

CHEMICAL & METALLURGICAL ENGINEERING



Specify genuine Rainbow—
"the right packing in the
right place".



Your Engineer Knows if It's *Genuine* Rainbow

He knows from long experience that there may be other red sheet packings but only one Rainbow.

He has learned to look for the diamond trade mark and the word "Rainbow" on every roll, for in no other way can he obtain Rainbow dependability.

A car builder in the Middle West, for example, once changed from Rainbow to a cheap red sheet. The failure of one gasket of this inferior packing on his main steam line caused a shut-down of his entire plant for 45 minutes. This experience cost his company more money than their entire packing purchases for over five years.

In most instances one failure out of 200 gaskets will cost you more money than the difference in price between cheaper sheet packing and Rainbow.

United States Rubber Company

1790 Broadway

New York City

*The World's Largest and Most Experienced
Manufacturer of Mechanical Rubber Goods*

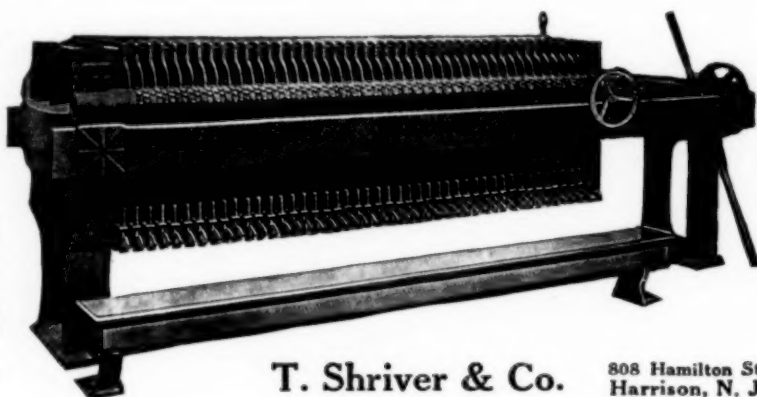
**For Big Production and Low
Operating Cost**

**SHRIVER
FILTER PRESSES**

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



T. Shriver & Co.

808 Hamilton St.
Harrison, N. J.

"Ruggles-Coles" Dryers

Have in every instance unfailingly met the requirements put to them. Explanation to this fact lies in our unaltered policy to recommend "Ruggles-Coles" Dryers only when we know they are the most practical for the purposes intended. Today, "Ruggles-Coles" Dryers are the recognized standards for thermal efficiency and low operating costs. They dry rapidly and uniformly; are extremely simple in operation; they are absolutely safe and cannot injure the material.

By virtue of their unusually satisfactory service, "Ruggles-Coles" Dryers are being put to a wide and varied usage in the drying of chemical and metallurgical products. That they have proved their superior merit is evidenced by numerous repeat orders.

RUGGLES-COLES ENGINEERING CO.
50 Church Street, New York
WORKS: YORK, PA.

CHEMICAL CENTRIFUGALS



"The Finest Extractor Made"

That's what most engineers said at the 1920 National Chemical Exposition on seeing the

"Hercules-Electric"

Patents Pending

Self Balancing—Bottom Discharge

Sizes 30 to 60 inch

Eastern Representative:

F. A. TOLHURST

40 So. 7th St., Philadelphia, Pa.

Southern Representative:

E. S. PLAYER

Greenville, S. C.

Canadian Representative:

WHITEHEAD, WINANS, LTD.

285 Beaver Hall Hill, Montreal, Canada

EAST JERSEY PIPE CO.- PATERSON. N.J.

CHEMICAL & METALLURGICAL ENGINEERING

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
ALAN G. WIROFF
Assistant Editors

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRW
Managing Editor

Volume 23

New York, November 24, 1920

Number 21

New Import and Export Classification Needed

WITH the expansion of the chemical industries, it has become necessary to rely more and more for commercial information upon the statistics of imports and exports compiled by the Bureau of Foreign and Domestic Commerce. There is urgent need for a new classification of these figures, as well as for the consolidation of the Bureau of Customs Statistics of the Treasury Department and the Bureau of Foreign and Domestic Commerce of the Department of Commerce. A plan to put these reforms in effect has been agreed upon by all concerned, but unless Congress can be induced to provide the necessary funds before Jan. 1, it will be necessary for the improvement to be delayed for another year.

As a result of studies begun some time ago, new classifications have been arranged. The new import classification covers 984 separate commodities, as compared with 700 in the present schedule. The export classification likewise has been increased from 700 items to 1,234. It was expected that these new schedules would be put into effect Jan. 1, 1921, but the additional work demanded of the Statistical Division of the Bureau of Foreign and Domestic Commerce, owing to the tremendous growth of chemical imports and exports since the war, makes it impossible to start work under the new classification unless Congress provides additional funds for statistical work.

At its last session Congress was asked by the Secretary of Commerce for \$400,000 for compiling foreign trade statistics, but no appropriation was made. It was proposed at the same time to transfer the control and expense of operation of the Bureau of Customs Statistics in the New York Custom House from the Treasury Department to the Department of Commerce and perhaps consolidate it with the Division of Statistics of the Bureau of Foreign and Domestic Commerce. The estimate of \$400,000 is approximately double the present cost of these two statistical bureaus which it is proposed to unite, but the additional amount was expected to take care of extension of import and export classifications; introduce more efficient methods for compiling and publishing monthly and annual reports; compile statistics of exports by states of origin; furnish special statistical statements to interested parties in more detailed form than is customary in the monthly summary; and otherwise improve the statistical service for the benefit of the Government, trade and commercial organizations and firms engaged in foreign trade. The advantages of this consolidation and improved service will be quite obvious to those who now have to deal with the separate bureaus.

It is now planned to request the Appropriations

Committee of Congress to hold a special hearing on this estimate in advance of the hearings on the annual appropriations for the fiscal year commencing with July, 1921, for the purpose of explaining the necessity for additional appropriations for statistical work in order that the revised import and export schedules may be put into effect Jan. 1, 1921. According to law the annual report on statistics of commerce and navigation of the United States with foreign countries is published with the close of a calendar year, thus making it necessary to initiate changes in the classification at the beginning of a calendar year. It is to be hoped that a post-war measure of such importance will receive sympathetic treatment at the short session of Congress, and we suggest that representatives of the industries concerned exert all legitimate influence to bring this about.

Production Costs And Commodity Prices

NO DOUBT a great many persons would disagree with a statement that in the orgy of high commodity prices from which the country has now begun to emerge prices were dictated by costs, and yet as to many industries there is ground for maintaining such a position. Of course the qualification must be made that very large profits were added to the costs before the selling prices were named, but that is another story. The manufacturer saw that it was a "sellers' market" and in endeavoring to produce at the maximum rate possible he had no incentive to hold down his costs, for any extra cost could be added to the selling price, with a liberal toll in profits.

The new idea in manufacturing is that selling prices are going to dictate costs. The seller is not going to make prices in future, as there is to be a "buyers' market." The buyer knows very little about costs, but is good at making comparisons between prices of the various things he buys. He may not be able to tell from its looks whether a factory makes overcoats or shoes, but if he finds that overcoats have come down to a certain relation with the pre-war price he expects shoes to do the same, or *vice versa*, according to which is the lower. When copper is selling at less than its 1913 price and less than its ten-year pre-war average he is suspicious of pig iron when it does not do the same thing. If the pig iron producer cites his costs the buyer, having now an opportunity to speak, is likely to say, "So much the worse for your costs." Then the merchant-furnace-man is likely to have a conference with the coke producer and the iron ore producer.

The great explosion has been the explosion of the theory that the dollar is worth only fifty or forty cents, or perhaps the proverbial thirty cents. One can spend

his dollars for copper, or pig iron, or wheat, or cotton, or movie shows, or various other things. The tables are turned. The profiteers talked about forty-cent dollars. Now the buyer has an opportunity to talk and he will inquire why his dollar will not buy as much of one thing as of another.

Time is a great corrective, and time is going to aid the buyer in coming into his own. If the producer has costs that are too high he will be given time to correct the situation. If the workman is still spending money and does not want to work hard he will be given time to spend the money and reform his mind.

In the readjustment of costs two distinct elements that make up costs are to be recognized. One of the elements is the efficiency of the manufacturing organization that produces, while the other is the profit of some one from whom raw materials or supplies are purchased. The first item is being shaken out. Machinery is as efficient as formerly, while some workmen are not. They do not produce as much per day as formerly. Every day of late one has heard of cases of a factory closing for one day or two days a week and finding its output increased instead of diminished, or of cases of 10 or 15 per cent of the workmen being "laid off," with the remainder producing more than the full quota had previously produced.

There are few manufacturing industries that do not buy large quantities of supplies. Those supplies have been high priced and have increased the cost. When inordinate profits are eliminated the costs of the manufacturer or assembler will be reduced. If the reduction does not occur voluntarily time will be given for reflection. While in the past increases have been handed up the line to the final selling price to the ultimate consumer, reductions will now pass down the line. The country will not be really active industrially until it engages in the construction work that is so much needed, the work for which the investor pays, and the investor will have definite ideas of what a construction job should cost him.

Western Industrial Growth

And Its Influence on Chemical Development

ECONOMICALLY the increase in population of the Western states is of more than local interest. The rapid growth of a few rather limited areas has resulted from agricultural or from industrial developments that have gained impetus during the last decade. Arizona and Montana, through irrigation, have become agricultural, no longer to be considered as mining states only. California south of Tehachapi is becoming an industrial region. Even in the San Joaquin and Sacramento valleys, which have become one almost continuous garden, there is considerable manufacturing in the larger cities. The San Francisco Bay district, at the gateway of an important avenue of trade, no longer handles only the articles of commerce passing through the port, but is supplying manufactured products of its own for export and for shipment to other sections of the country; in 1919 the value of manufactures was over \$750,000,000. More than two hundred new industries have been established during the first nine months of this year in the San Francisco district, and this number has been exceeded in the territory contiguous to Los Angeles. The Columbia River basin is developing along manufacturing lines and, together with British Columbia has established a paper and pulp industry which

should become of more than local importance. While the Puget Sound country and the Northwest as a whole is principally a lumber-producing region, the output of manufactured products is increasing. So the mountain states are emerging from the mining and grazing into the agricultural, and the Pacific Coast states from the agricultural and lumbering into the industrial stage of economic development.

The chemical industry is not a pioneer; it follows rather than leads and grows best where general manufacturing has become well established. Along the Pacific Coast where raw materials are available the chemical industries have a fertile field for growth, not only to meet local needs but also to supply the rapidly developing Oriental market for chemical products.

Good Rails Are More Than Sulphur Prints

TO WHAT end are all Dr. BURGESS' tests? "Why, to separate good rails from bad ones," is the ready rejoinder. But do they? These tests, probably the most minute study ever made of a rail rolling, performed in painstaking detail, picture rails of all sorts, like men from all over the globe—black, yellow, high cheek-boned, dolichocephalic. And they're all good! Witness the report from the railroad company: "There have been no failures of Hadfield rails or of the Maryland Specials."

A metallographist, if asked to state the fundamental axiom of his science, might respond that metallographical uniformity is synonymous with metallurgical excellence. But he would be placing the cart before the horse, for it is not always true even that metallurgical excellence demands microscopic homogeneity; furthermore excellence certainly does not stop with uniformity, nor is metallurgy limited by the microscope. Following analogous sophisms, are not metallographists, chemists and testing engineers in danger of building up a picture of what good metal ought to look like, analyze like, and test like; and then when they find a piece of metal which approximates this masterpiece, say, "Behold, here is a really excellent rail"?

Perhaps Dr. BURGESS has fallen into this trap when he says, "Recalling the greater uniformity of the sink-head over the comparison ingots as shown in nearly all other mechanical tests, in less segregation, greater homogeneity as shown by sulphur prints and etching, less amount and variability in discard to sound steel, the question of the significance and interpretation of the drop test may, it would seem, be raised with propriety," and then cites as evidence against the drop test the fact that it failed to show differences among the three Maryland heats. It was unmistakably able, however, to distinguish between the Hadfield ingots and the Maryland ingots, and the latter stood punishment better, something apparently which was not expected.

What does Service, the court of last resort, say? Its only remark as to relative quality is: "The average abrasion of the No. 1 Hadfield rails was 0.42 sq.in., that of the Maryland Special rails 0.37. Abrasion for No. 2 rails was 16.1 per cent for Hadfield and 9.7 per cent for Maryland Special."

CHEMICAL & METALLURGICAL ENGINEERING has been glad to devote all necessary space to present the record of the work described by Dr. BURGESS. It is instructive in many obvious ways, possibly not least of which is the reflections it ought to excite in the mind of a philosophical metallurgist—if there is such a person.

Trade Wastes and Stream Pollution

ATTENTION is directed by WILLIAM H. WELLS, of the New York State Conservation Commission, in a recent number of *Science*, to the need of more intensive study of the pollution of streams from trade wastes. When we consider the millions spent in carrying water to cities, in protecting watersheds, in filtering, etc., we observe how needful is uncontaminated water. A stream is, in a way, a living thing in which a great biological equilibrium is and must be maintained. As soon as this is disturbed we meet dangers to health and disturbance in the cycle of life. Sometimes one small industry is enough to bring this about, and unless precautions are taken the wastes of many industries are almost certain to do it. If the oxygen dissolved in water becomes diminished, the fish will suffocate, for water is to fish what both earth and air are to land animals. Organic wastes have the power to absorb oxygen from the water, and thus make it uninhabitable for fish life. It is rare indeed that fish are no more found in streams because of overfishing. They swim away to other waters because they cannot get enough air, or because they meet some trade waste that makes life unbearable to them.

The amount of contaminating material a water can absorb without injury to its various uses is strictly limited by the rate at which such substances may undergo physical or chemical change. This, in turn, depends upon the biological capacity of the stream to bring about this change.

Every trade waste needs special study, and splendid work has been done in individual instances. Generally speaking, however, we let by far too much pollution into our streams, using them merely as vehicles of transportation to carry offensive matter from our neighborhood to another whence fish have long since departed. There is room for much improvement in this connection. So far as pollution by sewage is concerned we believe that as soon as some practical method of drying sewage is discovered we shall see all of the sludge turned to inoffensive nitrogen fertilizer, while the chlorinated effluent will harm neither man nor beast.

Only Applied Research Produces Profit

A SOUND theory is always valuable, a correct result of careful research is always an asset; but until translated into useful and used form neither produces any dividends. In no field is this more certain than in chemical industry.

In his recent address, "Thrift in Coal," delivered before the Iron and Steel Institute on Oct. 22, GEORGE OTIS SMITH stressed this point very effectively. He was speaking of boiler-firing results in a large plant which prided itself on the high-grade fuel burned, about 15,000 B.t.u. per pound. This plant was getting only the equivalent of about 11,000 B.t.u. because of poor operating practice, and it is with full justification that Dr. SMITH said of the manager: "That coal user needed expert firemen more than chemists—better practice rather than more theory."

Such a situation might seem at first thought to be an indictment of the chemist. In some cases the defect is chargeable to the research man or the chief of the laboratory, but more frequently it is probably the manager or superintendent who is at fault. Any competent chemist, whether engaged only for the control laboratory work or for original research, is a potential

asset. However, his value as an operating asset is only potential until the manager gives him an opportunity, indeed, encouragement, for direct application of laboratory results in the plant.

Teamwork in the relationship between chemist and superintendent or chemist and manager is a first essential. Each has an important element to contribute in the application of the laboratory results. The laboratory data are cold figures without the interpretation of the chemist. But an impossible situation and impractical results may often result if the interpretation is solely upon the basis of laboratory ideas. A sympathetic understanding of the limitations of the laboratory as well as cordial appreciation of its possibilities will do much to vitalize the product of the workers with beaker and test-tube. On the other hand an intelligent study of the practical plant problems by the chemist, combined with tact and patience in seeking to apply laboratory results, is also an essential prerequisite to success.

Knowing Something About The Other Fellow's Business

DURING the discussion of a paper before the American Zinc Institute in Chicago recently someone stated that one of the reasons for the high recovery of zinc in European smelting practice was the fact that the clays used in making the retorts were of better quality abroad. If the Institute had been informed in the work of the American Ceramic Society this erroneous observation would have been immediately challenged, for the fact is that the United States produces clay of every sort equal to or better than the European product; and that several grades of German clay held at a premium previous to the war now sell at a discount on the American market. The metallurgist must work with the ceramist to find the solution of the problem of iron, lime and silica content in zinc slags, and the consequent reactions on retorts; to know that a refractory composition is often made less refractory by the addition of a more refractory material to the mix, as shown in eutectic diagrams. In turn the ceramist must be advised as to the composition of various ores and slags in order to select the better clays for refractories. Only by a constant interchange of ideas during the rapid progress of both industries can the best results obtain.

It is equally necessary that the chemical engineer be informed as to the efforts of the mechanical engineer in improvement of machine design. Glaring examples of lack of such knowledge exist in many chemical plants today, with absurd designs worked out by chemists where standard machinery might have been applied. Likewise the chemical engineer must also know the better structural methods developed by the civil engineer, or much waste results.

And so on in every line of engineering practice. Instances might be multiplied, all leading to the conclusion that progress will be most effective when we have the closest co-operation among related interests. Just how this can best be accomplished is problematical. Much depends upon the general intelligence and breadth of vision of the individual—upon a natural realization of the incompleteness of his own profession and its probable dependence in some detail or other on a related subject. The next best thing to knowing a subject first-hand is to know where to look for the information. Usually it is to be found close at hand, though sometimes in unexpected places.

Readers' Views and Comments

The Chemist and the Coking Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much pleasure the article by R. S. McBride on "The Chemical Profession, Its Opportunities and Responsibilities," which appeared in CHEMICAL & METALLURGICAL ENGINEERING of Sept. 8.

In this article I note the following paragraph:

We have whole industries neglected by the chemist. Coking, except in a very few cases, is undirected by science. It remains a mechanical-engineering art, almost, in fact, a trade, so largely is it guided by rule-of-thumb methods.

I presume that in writing the above the author had especially in mind the beehive coking industry, regarding which the statement is entirely correct. I think we can say, however, that the coking industry in America is today the byproduct coking industry. It is some years since the production of byproduct coke exceeded that of the beehive oven and the problems that are before the producers and users of coke are essentially confined to the byproduct oven. The United States Geological Survey stated in its last annual report on this subject that the capacity of the byproduct coking plants of the country is now approximately 80 per cent of the total requirements of the metallurgical coke users.

If we accept this statement, I believe there is no doubt that there are only a very few industries in America in which the chemist plays a more important part. The two systems of byproduct coking which are prominent in this country are represented by the Koppers Company of Pittsburgh and ourselves. The Mellon Institute of Pittsburgh is very largely given over to research work. This was founded by the financial interests which control the Koppers Company and it is working very closely with that company in the solution of chemical problems which constantly come up in the development of the byproduct coking industry. Our own company has an organization of considerably over one hundred chemists, outside of those doing routine work, and the time of these men is largely taken up in the study of problems connected with the development of the coking process and the use of the products obtained therefrom. Practically every proposed modification of an old method and every problem connected with a new method, or with a different or more complete utilization of products, is submitted to be worked out by these research men, and every process connected with the industry, from the routine analyses of the coals used clear through to the finished products ready for shipment, is constantly checked by our chemists.

Not only is this the case in the operations of the two companies named, but every independent operator of byproduct ovens has its organization of chemists, and the United States Steel Corporation, which operates a considerable number of plants, has an important central laboratory in which the men are constantly engaged in research work, looking to the betterment of the operation in addition to the routine checking of every part of the process which, as far as I know, is

carried out at every byproduct coking plant in the country.

I know you will be glad to have these facts and I believe the byproduct coking industry is one of the best examples of the importance of the chemist in the development of modern industry.

Semet-Solvay Co.,
Syracuse, N. Y.

W. H. BLAUVELT.

Synthetic Production of Hydrocarbon Fuels

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with great interest Mr. Acheson's letter in your issue of Aug. 18, and comment thereon by Mr. Birdsall on page 606 of the Sept. 29 issue.

The question raised by these gentlemen is one which will well merit attention. Mr. Birdsall's suggestion as to the production of a pure hydrocarbon—i.e., pentane—in place of the natural mixed products is a likely result. In other words, when man produces a hydrocarbon he will probably excel nature, just as he generally excels her when he duplicates any natural product by controlled processes.

The gentlemen mentioned may be interested to know that I have developed a successful method of effecting an aqueous solution of carbon from cheap materials such as coke, etc., but have not as yet succeeded in producing synthetic products of commercial use.

Cleveland, Ohio.

ARTHUR R. BULLOCK.

A Note on Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—Permit me to second most heartily the thought expressed in the editorial entitled "A Note on Research," published in your Oct. 13, 1920, issue. There is very grave danger that the periodical effort to "organize" and "systematize" research, which is just now in full swing, may defeat its own end. It is no more possible to place real research on a business basis than to organize the writing of poetry and music. Who, for instance, would look for a real contribution to dermatology from the chemist to a state geological survey, and yet this has recently happened.

University of Alabama,
Dept. of Chemistry and Chemical Engineering.

STEWART J. LLOYD.

German Exporter Asks Cash Against Documents

A prominent German house exporting chemicals, drugs and related articles has published in Argentina the following statement of its terms of sale:

In regard to our conditions of sale, we must demand payment against delivery of documents by reason of the present economic conditions. The unfavorable state of German exchange carries with it a great risk since we sell in Swiss francs. Should our exchange improve, we will experience a loss which may be very considerable between the date of the invoice and receipt of payment against documents.

By giving credit to our clients this risk would be too great and we would be obliged to invoice in German marks, leaving to our customers all the risk of the exchange, a thing which is not to their interest. The payment of our invoices made out in Swiss francs may be made, according to the desire of the client, also in marks or American dollars at the exchange of the day.

Chemistry and the Food Industry

An Outline of the Far-Reaching Importance of Applying the Principles and the Technique of Biochemistry to the Solution of Problems Relating to the Industries That Use Agricultural Raw Materials

By CARL L. ALSBERG*

THE food industry is the basic industry and the largest industry of every country. It is the key of all key industries. The value of its products far exceeds that of any other industry or of any group of them. In 1914 the foods manufactured in the United States were valued at \$4,816,709,000—and this figure does not include foods which were sold for consumption without going through some form of manufacturing process. In that year iron and steel products had a value of \$3,223,144,000. The largest single food industry in point of value of the finished product is that of the slaughter house, the products of which in 1914 were estimated to be worth \$1,651,965,000. Improvements and economies affecting the production, preparation, distribution and preservation of food hold a place of vital importance to the people far above that occupied by any other industry.

LIMITED APPLICATION OF SCIENTIFIC RESEARCH TO FOOD INDUSTRIES

Despite the tremendous importance of the food industry, the application of the results of scientific research to it hitherto have been limited. Such efforts have been toward improving the methods of producing raw materials—that is to say, to increasing either the yield of crops per acre or reducing the labor required for the production of each food unit. Until recently, with a few exceptions such as sugar refining, milling and brewing, but little application of chemistry or chemical engineering has been made to the manufacturing of the raw material produced in agriculture into the finished product suitable for use upon the table.

The reason for this is very simple. The manufacturing of the raw materials into products fit for food was conducted practically entirely in the home. Just as carding, spinning and weaving were transferred from the home to the factory more than a century ago, so during the past few decades there has been a similar gradual transfer from the home to the factory of many of the processes of manufacturing finished food out of the raw materials. This translocation is only in its beginning. Ultimately it will have a more profound effect upon civilization than the development of the textile industries, for it will open the gates of an immense reservoir of labor, the labor of women, who comprise half the population. Whether or not the prospect is a pleasant one is another matter. Even today the demand for canned goods is a good index of unemployment. The urban laborer's wife seeks to lighten her burden, when the family is prosperous, and the first method that suggests itself is the purchase of ready-to-serve foods.

In this transfer the methods of the home were the first to be used in the factory. Usually these methods, satisfactory enough for small-scale operations, are

wasteful and impracticable on a large scale. A process that may be sanitary and cleanly in the kitchen often becomes filthy and dangerous in the factory.

CHEMICAL CONTROL IN FOOD MANUFACTURING AS A RESULT OF THE FEDERAL AND STATE PURE FOOD LAWS

Until very recently, but few factories had introduced chemical methods of control. The introduction of these methods has been hastened by the necessity of controlling products to meet the requirements of Federal and state pure food laws. It is not the least of the services rendered by such legislation that it has opened the eyes of many a manufacturer to what trained men can accomplish in improving processes, reducing waste and eliminating uncertain rule-of-thumb methods. Today, in most of these plants, chemists would be retained if all food legislation were wiped off the statute books.

Food manufacturing, since it is so new as an industry, presents to the chemist a multitude of problems, many of them of the most profound economic importance.

CHEMICAL PROBLEMS TO BE SOLVED IN THE MILLING INDUSTRY

In the milling industry, which was among the first to introduce exact factory control, there remain problems well worthy of any chemical engineer's attention; problems, the solution of which would influence human affairs as profoundly as any discovery in metallurgy. Thus wheat must be moistened—"tempering," the miller calls it—before milling. How much it is moistened depends upon the head miller's judgment. He must base his judgment not merely upon the characteristics of each lot of wheat to be milled but also upon the weather. It is self-evident that on a humid day fewer fine particles pass through a given sieve than on a dry day. If the wheat is too moist or not moist enough, or there is a change of weather which checks the dessication of the stock as it passes through the mill, particles of flour may pass over sieves that should pass through them. Thus perfectly good flour may pass into the feed-bin instead of into the flour sack. It is one of the head miller's duties, by constantly readjusting the equipment, to see that this does not occur. In doing this he relies chiefly on his judgment. There can be no doubt that if the tempering of wheat were to be done in all mills on some still-to-be-determined scientific basis; and if the operation of milling were to be conducted under controlled conditions of temperature and humidity, say in an inclosed system, the amount of perfectly good flour that could be saved for human consumption would be tremendous.

Though wheat is not a particularly good food, it is supplanting other bread grains all over the world. This is partly because it is, in a sense, a time-saving crop, and partly because it contains gluten. An hour's labor

*Chief, Bureau of Chemistry, U. S. Department of Agriculture.

will produce more food energy in the form of wheat than in almost any other form. By virtue of the properties of its gluten, wheat flour when mixed with water yields a tenacious elastic mass, dough. The carbonic acid gas generated by the yeast used to leaven the dough cannot therefore escape into the atmosphere as it does from a mixture of corn flour and water. The gas bubbles are held enmeshed in the gluten in such manner that when the gluten is set by coagulation in the oven, the bread has a peculiarly desirable flavor and texture. The property of gluten to yield a tough elastic dough makes it possible to bake leavened bread. This property it owes to its physical state, and not, so far as present knowledge goes, to the chemical structure of the molecule of the proteins of which it is composed. There is, as far as it is possible to foresee at the present time, no theoretical reason why other proteins in other bread grains are not susceptible of such manipulation as to give to them the physical properties of gluten. It is a problem of colloid chemistry. To discover the method by which this can be brought about will make it possible to produce a loaf of leavened bread from other materials than wheat. The economic significance of such a discovery is so obvious that it does not require elucidation.

This is not the only problem of the cereal industries. Baking is still largely an art and not a science. Even the grading and standardizing of its basic raw material, flour, is in its infancy. Years of research will have to ensue before it will be possible to standardize fully the processes of baking and to control such factors as the reaction and moisture content of the dough and the conditions of yeast growth. Even the factors that control the "going stale" of bread are not understood. It certainly is not a mere drying out. In some localities at times as much as 7 per cent of the commercially baked bread has gone stale before it was sold.

ECONOMIC IMPORTANCE OF THE UTILIZATION OF GRAIN SORGHUMS

One of the biggest problems of the cereal industries of the United States is the utilization of the grain sorghums, such as kafir, feterita, proso, milo maize and their relatives. The amount of land that can be kept under cultivation in the semi-arid portion of the United States, which includes much of western South Dakota, Nebraska, Kansas, Texas and much of the Southwest generally, depends to no inconsiderable degree upon the price of grain sorghum. Anything that will widen the market for this crop will inevitably make agriculture in this section more profitable and will extend the area of this very large portion of the United States that can be subjected to cultivation.

Grain sorghum has about the composition of corn. Before the war it was sold at a considerable discount under corn because practically the only outlet for it was in competition with corn as stock feed. Under normal conditions the price should be something like 15 per cent under that of corn, since it has a corresponding lower feeding value. There is, therefore, a demand for a commercial outlet for grain sorghum and it is already beginning to be used for alcohol production.

It should be possible to find a future outlet in the creation of a kafir corn products industry producing essentially the same materials as the corn products industry—i.e., starch, glucose, dextrine, oil and byproduct feeds. In addition, there are indications that wax may also be obtained. The man who creates this or a similar industry using grain sorghum as raw material

will as surely confer a tremendous blessing upon the semi-arid regions of the United States as he who builds an irrigation system. This man must be a chemist or a chemical engineer.

OTHER CHEMICAL PROBLEMS IN THE DAIRY INDUSTRY

There are many other problems in the dairy industry demanding study. The production of butter and the control of its composition and texture involve problems in the chemistry of emulsions worthy of any physical chemist's attention. Indeed, it is by no means inconceivable that there is some more efficient way for cutting the emulsion which we call milk than by the ancient mechanical process of churning. The production of butter substitutes, a rapidly growing industry, presents quite analogous problems. To give to these substitutes all the nutritive qualities of butter is a problem quite capable of solution. It awaits the attention of some biochemist.

CHEMICAL PROBLEMS IN CATTLE FEEDS

Dairying is not the only part of animal production that is in process of being made over by the chemist. He is bringing about a revolution in the use of feeding stuffs for beef, pork and milk production. Corn, for example, is not a very efficient feed, and biochemists have shown that this is due in part to a deficiency of the corn proteins in certain amino acids. They have shown that these acids are present in abundance in such materials as cottonseed, copra and peanut cake. Such materials added to corn should make of it an efficient feed. This has been demonstrated conclusively for one of the feeding stuffs derived from corn and inappropriately known as corn gluten. Upon a diet containing corn gluten alone as the only protein, a young animal will grow but slowly. If, however, as little as one-third of copra cake, which is cheaper than corn, be added, the animal will grow rapidly. With a suitable mixture of corn and such materials as copra cake or peanut cake it is possible to produce an optimum rate of growth with as little as 10 per cent of protein, the costly ingredient of the diet. The result is that a vastly smaller amount of feed need be used to produce a pound of live weight, while the time required is immensely shortened. What the application of principles like this means to the cost of producing meat and milk and what they mean to the mixed feed industry with an annual output amounting approximately to \$700,000,000 is obvious.

CHEMISTRY IN THE SUGAR INDUSTRY

Even the sugar industry, upon which chemists, in the creation of the beet sugar industry, have already exerted a profound influence, still presents a multiplicity of problems. It is by no means certain that sugar cane and sugar beets are the ideal sugar plants for all climates and soils. At least one other plant, the nipa palm, shows great promise, and there is no telling what of commercial value a systematic chemical survey of the vegetable kingdom would uncover. Moreover, sugar refining demands simplification so as to make possible the economical production of white sugar upon the plantation with all the economies in labor, transportation and handling therein involved. These, too, are problems that will be solved by the application of the principles of colloid, physical and biological chemistry, for they involve the removal from the sugar plant juices of colloidal materials and the control of enzyme action,

factors that are intimately connected with the formation of molasses, which the sugar house chemist usually endeavors to suppress.

CHEMISTRY IN THE INDUSTRIES UTILIZING SUGAR

There is a very great amount of work to be done in the industries that utilize sugar as their raw material, particularly the confectioner's industry. The going stale of candy is, in the majority of instances, merely the crystallization of the sugar. It should be possible by the application of the principle of physical chemistry to prevent most of these losses. Hard candies are boiled to a definite temperature mainly for the purpose of inverting a certain proportion of the sugar that they contain. This is, therefore, a more or less haphazard matter. If too little invert sugar is formed in the process of boiling the candy, the sugar will crystallize and the candy will rapidly become stale. If there is too much invert sugar formed, the candy will be hygroscopic and will become sticky in hot weather and not salable for these reasons. This is a very important problem to the confectionery industry and one that should be capable of solution by very simple chemical studies.

CHEMISTRY OF FOOD FLAVORS

Another carbohydrate industry that demands the attention of physical chemists is the manufacture of jams, jellies and preserves. The conditions for jell formations, for the inversion of the sugar, the preservation of the rich ripe flavor of fruit and the achievement of the best possible texture are all problems of colloid or physical chemistry to which practically no attention has been paid by properly trained men. It should be possible for such men to vastly improve the methods of producing these materials and to introduce very important economies and improvements in the processes. Indeed the whole matter of the chemistry of food flavors is one of tremendous economic importance, for food prices often depend not upon food value, but upon palatability. With a complete knowledge of the chemical nature of flavoring materials it would be possible to give to cheap but nourishing foodstuffs a high degree of palatability.

These problems are of the utmost importance to the canning industry since the retention in the preserved finished product of color, flavor and texture is one of the ends it is striving for. Moreover, containers and methods of sterilization have by no means been perfected. The prevention of the deterioration of canned goods, of the rusting and perforation of the cans, of the blackening and change in color of corn and other products—these are but a few of the problems that confront the chemical adviser to the canning industry. Some of these problems, no doubt, will be solved in part by abandoning canning as a means of preservation and substituting dehydration—a new and, at the moment, rapidly developing industry that presents to the chemist and the chemical engineer a host of its own peculiar problems.

IMPORTANCE OF BIOCHEMISTRY IN THE SOLUTION OF FOOD MANUFACTURING PROBLEMS

An innumerable number of examples might be cited to show what the chemist has accomplished in the food industry. Such examples have been avoided on the assumption that what has been done, as, for example, in the hydrogenation of oils, will be known to the readers of this journal. It seemed preferable to give a few

examples from the field that remain to be developed. It is evident from the examples given that these opportunities belong very largely to the biochemist and that future developments must follow the performance of fundamental laboratory research which, in this field as in any other, must precede practical application in the industry. Until recently the science of biochemistry has been cultivated only in medical faculties. Biochemistry in this and in other countries has been a hand-maiden to medicine. The time has come when a new type of biochemist must be developed who applies the principles and the technique of biochemical research to the problems of agriculture and the problems of the industries that use agricultural raw materials. The time has come when chairs of biochemistry should be found in technical schools as well as in schools of medicine.

The Arsenic Industry in Japan

Arsenic is found in Japan as an ore, as well as being a byproduct from the smelting of copper and lead, reports Vice-Consul Goodier of Yokohama.

Ore deposits are said to be fairly large in the Prefectures of Oita, Miyazaki, Hiroshima, Hyogo, Shimane and Okayama, their percentage of arsenic ranging from 15 to 30 per cent.

In 1918, 1,828,198 lb. of ore valued at \$9,204 was produced. The output increased to 2,133,281 lb. in 1919, but its value decreased to \$6,975. This did not include ore used at the mines by the companies for producing arsenious acid, or crude "arsenic."

Concerning this "acid" available statistics give the total production in 1918 as 877,651 lb. and 2,862,653 lb. in 1919. Its exact value is unobtainable but may be estimated from the declared export returns of consulates in Japan, excluding Taiwan and Dairen. The total export to the United States in 1919 is given as 1,821,340 lb. with a value of \$70,739, of which 1,387,388 lb., valued at \$48,337, was from Yokohama. The total export from Yokohama to the United States during the first seven months of 1920 is stated as 1,102,020 lb., valued at \$39,510.

METHODS OF PRODUCTION

Arsenious acid is produced in Japan by direct reduction of arsenic ore and also as a byproduct in copper and lead smelting. The former method has been used on a small scale for the last ten years, but only quite recently have byproduct methods been installed by certain copper and lead mining companies in endeavors to consume poisonous gases, etc., from smelting operations.

Under the direct method of producing arsenious "acid" one company is said to have a capacity of about 3,333 lb. at a firing. The charge is renewed about twenty times a month. From ore of 20 per cent arsenic the output of one furnace will make approximately 13,333 lb. of crude arsenic each month.

About 20 per cent is lost in refining.

The three largest manufacturers of arsenious acid in Japan are said to approximate a monthly output of seventy tons (crude only), thirty and fifteen tons (both refined), respectively.

The arsenic content of acid thus produced by both methods is, roughly, 95 per cent in the crude and about 97 to 99 per cent in the refined.

If the industry is given adequate support by large companies, it is claimed that 4,000 tons of acid per year can be produced from known sources.

Electric vs. Combustion Furnaces for Low Temperatures

Electric Furnaces Have the Advantage in Temperature Control, Reliable and Permanent Source of Heat, and Maintenance—Cost of Power Is Counterbalanced by Economy in Space, Auxiliaries, and Operation, While the Quality of Product Is Greatly Enhanced

By FRANK W. BROOKE AND GEORGE P. MILLS

AS A heating agent, electric energy was first used in a commercial way about fifteen years ago. The application made at that time was in a single-phase melting furnace. The development of the electric arc-melting furnace is well known. The application of electric energy to processes requiring low temperatures ranging up to 1,800 deg. F. (1,000 deg. C.) is more recent, but has now reached a state of perfection and during the last three years has made remarkable strides in the steel industry, many important large installations having been made during this period.

Probably one of the best means of explaining the salient points of an electrically-heated furnace is by comparing its characteristics with the characteristics of fuel-fired furnaces in general use. It is recognized that excellent results in the heat-treating field have been obtained by the use of various types of combustion furnaces, and it is our purpose not to minimize this development, but to emphasize the direction of the most recent progress.

PRINCIPLE AND DESIGN

An electric furnace, whether of standard or special design, consists essentially of a steel shell properly reinforced and supported. Against the shell is laid up an ample thickness of high-grade heat-insulating brick arranged in three or four courses with all joints broken. The furnace lining of firebrick is placed inside and bonded to the insulating brick. The heating element preferably consists of very rugged ribbon resistors hung on insulating brick, which are built into the firebrick lining.

The rugged construction of the electric furnace compares most favorably with the construction of the hearth, walls and roof of the combustion type of furnace, which are necessarily cut up by ports, flues, combustion chamber, etc. These openings, being subjected to the high flame temperatures, constitute one of the chief weaknesses in the construction of the combustion furnace. The elimination of these features not only allows the most rugged construction and requires the most limited floor space, but reduces the design of the electric furnace to a scientific problem. Known quantities are dealt with throughout.

On account of the simplicity of principle and design, the electric furnace lends itself admirably to many forms of construction. Some of the more common forms are:

- (1) Horizontal chamber type, in which the work is charged and withdrawn through the same door.
- (2) Vertical cylindrical type with top cover.
- (3) Horizontal tunnel type, in which the work is charged in one end and discharged at the other end.
- (4) Car bottom type.
- (5) Conveying type.
- (6) Recuperative type, in which the hot outgoing

work provides energy for preheating the cold incoming work.

CHARACTER OF HEAT

In the best type of fuel-fired furnace, the heat is generated by the combustion of the fuel with the oxygen of the air at a temperature far in excess of the actual degree required in the work to be treated. This heat is produced in a separate combustion chamber and has to be carried through a series of flues, false bottoms, double arches and port-holes, all of which absorb a considerable amount of useful heat. Even then there is a great element of uncertainty in distributing the heat uniformly over the material treated. Another phase to be considered is that, where the material to be treated is not all of uniform section, the result of the high temperature gradient is to overheat the thinner sections in order properly to heat the thicker sections. Gases leave the furnace at a high temperature, and even with the regenerative type of combustion furnace a large percentage of the heat developed is wasted.

Heat in the electric furnace is generated in resistor units distributed over the interior of the furnace, and may be produced at a temperature only slightly higher than that to which it is utilized by the work. This is important, as it eliminates the possibility of the surface of the work being overheated or burned while the inner masses are coming up to temperature. As no combustion takes place, no gas or air is blown through the furnace. On the other hand, the atmosphere in the furnace is dead or quiet, and full advantage is taken of penetrating, uniform radiant heat. The energy being confined, it is taken up by the work at the maximum rate at which the surface will conduct heat to the inner masses.

TEMPERATURE CONTROL

Accuracy and uniformity of temperature control are obtained in the electric furnace to a degree that cannot be produced in any combustion furnace. On a small furnace all of the heating elements are connected to the power supply circuit through one automatic control panel. In larger furnaces, or where the process requires two or more different temperatures in the same furnace, the processed material being conveyed through the furnace, the heating elements are divided into separately-controlled zones. It is an easy matter to provide a complete heating, holding and cooling cycle, with time and temperature automatically controlled for the complete cycle.

On account of the fact that the heating elements may be so distributed as to radiate additional heat energy in the zones subject to the greatest losses from radiation, excellent uniformity of temperature is maintained throughout the furnace. Temperature uniformity throughout the furnace within plus and minus 5 deg. F. is the usual condition obtained.

With any form of combustion furnace it is necessary to regulate the temperature by means of rate of firing, operation of dampers or valves, which means that the temperature control is entirely dependent upon the ability of and care taken by the operator. In the combustion type of furnace it is very difficult to arrive at a true indication of the temperature of the material to be treated, owing to the fact that there is a large difference of temperature between the source of the heat—namely, the flame—and the material to be treated, and also because the most usual location of a pyrometer tube is such as causes the gases to impinge upon it, which again gives an erroneous reading, both of them higher than the true reading of the work itself.

It is also a very common practice, especially in the steel industry, to "soak" the steel to be treated. This practice of soaking in combustion furnaces is usually a matter of playing safe, because there is no true method of ascertaining when the steel itself is at the correct desired temperature for the heat treatment, and the length of soaking is invariably decided on from past experience, always at the expense of the amount of fuel required per ton of steel to be treated. There is also a practice of going to a higher temperature than is really necessary, for the same reason, as the metallurgist wishes to make absolutely sure that he has gone above the recalcence point of the particular steel he is treating.

The electric furnace fulfills two very desirable objects, the first being that with first-class recorders the true point of soaking can be determined as soon as it is reached. The recorder also shows not the temperature of the furnace nor the temperature of any impinging flame, but the true temperature of the work itself, and if the metallurgist requires a very fine grade of steel for any particular purpose he may go just as near to the recalcence point, with perfect safety, as he desires.

FUEL COMPARISONS

Oil as a fuel, especially under present-day conditions, has the following objections: It requires in proportion a very large amount of air, quite a lot of which, unless the furnace is of the muffle type, comes in contact with the material to be treated, and if this material is of an oxidizable nature it will scale. Other materials, such as enamel, may be affected or completely destroyed by contact, not only with the air, but also with the oil or products of combustion. If these features are to be avoided in combustion furnaces, muffle types of furnaces have in a good many cases to be resorted to, or else the material has to be packed with some packing material in boxes, both of which very seriously affect the thermal efficiency of the furnace and thereby the cost of fuel.

Natural gas in nearly all its present fields has to be supplemented, during certain parts of the day, by artificial gas, which at once lowers its heating value. This occurs at the time that most manufacturers require the greatest supply and, because of this demand, artificial gas has to be supplied to the main, thereby reducing its heating value at a time when it is most needed.

One of the most important political questions in the world today is to assure an adequate supply of oil for the future. Some of the figures published by the Government must give every manufacturer serious consideration for the future. In addition to this, the supply is also subject to a good many economic con-

ditions, such as strikes, embargoes, car shortages, for which there is only one practical solution to the individual manufacturer, which is to put in a very large storage capacity. This calls for a high first cost installation and automatically increases the seriousness of the congested condition.

In the case of coal, while our future supply is undoubtedly adequate for some time to come, the same economic conditions exist.

In the case of electricity as a fuel, the manufacturer need not have any consideration for storage or future supply. The storage is taken care of for him by the large public utility companies, which by their charter, have first priority on fuel supplies, and the wonderful water-power resources have been tapped only to a small extent.

ITEMS TO INCLUDE IN FIRST COST

In comparing the first cost of heat-treating furnaces, the purchaser often compares the cost of the furnaces only. This is decidedly unfair toward the electric furnace, and a true comparison can be made only by figuring up the total first cost, not of the furnaces, but of the complete installation. Thus, in an oil-fired furnace, it is only fair to figure in the cost of storage tanks, the cost of all the piping and the cost of the blowers or compressors, as the case may be, for the air supply, and, in a good many cases, new railway sidings. In the case of coal and other fuels, it is often necessary to put in new or additional sidings, or to have trestle work, supply bins or cranes, together with handling apparatus.

The space occupied by any type of combustion furnace for a given tonnage of material to be treated per day is very much larger than any type of electric furnace. When to this is added the extra space that is always required by combustion furnaces for their auxiliaries, such as storage tanks, siding, compressor rooms, ash disposals, etc., the comparison should be given very serious consideration.

MAINTENANCE

Four or five years ago, in discussing electric furnaces of the resistance type, one of the most usual questions was: What is the life of the heating units? And the makers of the electric furnaces had to reply in terms of hours, such a thousand hours or two thousand hours, as the case may have been.

With the remarkable progress made, however, during the last three years, this has been entirely eliminated, and the life of a heating unit today may be stated to be indefinite, as heating units that have been in operation for over two years on a commercial basis, day in and day out, are still as good today as the day they were installed, and their only source of breakdown would be mechanical, when the furnace is of a poor design. The refractory lining of an electric furnace has a remarkably long life. This is because of the principle on which the furnace works, whereby the temperature of the heating units is only slightly above that of the temperature desired, and for all purposes where the electric furnace of the ribbon resistance type is used the temperature is so well within a safe limit for refractory material that there is no burning out of the bricks in the furnace.

This is not the case in combustion furnaces, where high local temperatures and impinging of the flame on such parts as baffle walls, flues, portholes, etc., cause a

very serious wearing out or breakdown of the brick lining. In the case of oil, too, there is always a lot of mechanical maintenance, due to either dirt in the oil or, during the cold weather, the oil being very heavy and choking up small parts so necessary in this type of installation. Whereas, in the case of electricity, once the busbars and wiring are installed the flow of electricity is absolutely constant.

COST OF OPERATION

There is one correct way in which the cost must be figured in order to arrive at a true conclusion. This is to figure the total cost of a given process per unit of salable output. The total cost must include overhead—such as taxes, interest and depreciation—which vary with the initial cost of the installation and its lasting qualities; factory space occupied; repairs and maintenance; cost of fuel, including all labor incident to the handling of the fuel and disposal of ashes and refuse.

When the total cost per day or per week is arrived at by including all of the above items, it should be divided, not by the total number of units produced by the furnace, but by the number of units which pass inspection.

It is most unfair to compare, as is often done, the cost of electricity with the cost of oil or coal on the car. With the electric furnace the heating agent—that is, the electric power—is measured by meter at the control panel and the total cost of the "fuel" is the number of kilowatt-hours used, times the rate. With the coal-fired furnace expensive labor is used from the time the coal car is placed on the siding until the ashes are placed on the dump. With the oil-fired furnace labor is necessary for the keeping of the oil storage, pumps, piping and burners in good operating condition.

High temperature gradient is not necessary in the electric furnace. The repairs and maintenance on the electric furnace, therefore, are negligible. With the oil- or coal-fired furnace, temperatures up to 3,000 or 3,300 deg. F. (1,700 deg. C.) must be taken care of in the combustion chamber and flues. The maintenance of these parts of the combustion furnace, therefore, is quite an item and must be figured.

Space occupied by the electric furnace is always less than that occupied by a combustion type of furnace. When the fuel storage capacity required by the combustion type of furnace is considered, the comparison is greatly in favor of the electric furnace. This is an item to be considered in the cost of operation.

Due to the remarkable temperature control and uniformity of heating obtained in the electric furnace, rejections due to spoiled work have always been less in the electric furnace than in any combustion type of furnace. In some classes of product very few rejections will double the cost of the heat-treating process.

The cleanliness surrounding an electrical installation of any type is too well known to require description. The high degree of insulation and the remarkable degree of thermal efficiency which can be maintained in the electric furnace result in a clear surrounding atmosphere that is never higher than the normal temperature of the shop—a feature worthy of consideration. Voltage on the furnaces is never of high order. In most furnaces arrangements can be made where the current, and thereby the heat, is automatically cut off as soon as the doors begin to open. There is no danger from ex-

plosions or "gassing," and from the safety engineer's point of view these installations are ideal.

SUMMARY

The advantages of the electric furnace over combustion furnaces may briefly be summarized as follows:

1. Absolutely automatic temperature control.
2. Saving in labor—no handling of coal, ashes, oil, storage, pumps, etc.
3. Upkeep cost so small as to be inconsiderable.
4. Saving in space occupied.
5. Large saving in costs due to reduction of rejections in finished product.
6. Improved product.
7. High thermal efficiency.
8. Ideal shop conditions.

Philadelphia, Pa.

South African Trade in Soap

The total amount of common and brown soap imported into the Union of South Africa in 1913, a pre-war year, was 6,626,476 lb., valued at \$273,331, says Consul General George H. Murphy of Cape Town in *Commerce Reports*. The principal countries supplying this soap were the United Kingdom, 5,508,884 lb., valued at \$224,681; Australia, 857,171 lb., valued at \$37,326; and the United States, 213,169 lb., valued at \$8,145.

In 1918 the total imports amounted to 725,692 lb., valued at \$63,460. This was supplied as follows: United Kingdom, 172,843 lb., valued at \$15,558; Australia, 154,142 lb., valued at \$9,868; and the United States, 369,179 lb., valued at \$34,892. The total exports in 1918, consisting almost entirely of domestic produce, amounted to 3,112,966 lb., valued at \$317,325. Most of these exports went to contiguous countries in the following proportions: Madagascar, 1,162,845 lb., valued at \$109,077; Southwest Protectorate, 723,441 lb., valued at \$14,488; Portuguese East Africa, 337,744 lb., valued at \$35,374; Belgian Congo, 258,144 lb., valued at \$30,921; British East Africa, 242,299 lb., valued at \$27,290; and Zanzibar, 222,437 lb., valued at \$23,694.

This decrease in the imports and the large increase in the exports are due almost entirely to the establishment in South Africa during the past few years of several large soap manufacturers, among which are Lever Bros. (Ltd.), of England, which now has a practical monopoly of the laundry-soap business in South Africa. This soap retails for 1s. 9d. (42c.) for a package of six cakes, each cake being approximately 1 x 2½ x 3 in. in size.

The customs duty in the Union of South Africa on imported laundry soap is 4s. 9d. (\$1.14) per 100 lb. or 25 per cent ad valorem, whichever duty shall be the greater. A rebate of 7d. (14c.) on each 100 lb. or 3 per cent ad valorem, as the case may be, is granted on the product or manufacture of the United Kingdom or reciprocating British colonies.

While the market is limited and will be even more so with the growth of the domestic industry, the only possible way in which to reach it would be by a great amount of advertising and by placing an agency in the hands of a progressive manufacturers' agent. Such manufacturers' agents often cover the whole Union, calling upon the entire wholesale trade. In placing products with one wholesale house this often restricts the business to the clientèle of that particular house, as most of the wholesalers prefer to have exclusive agency rights in the products that they handle.

The Fundamentals of the Electrolytic Diaphragm Cell*—I

Detailed Study of Brine Composition and Products During Electrolysis in Diaphragm Cells—Current, Decomposition and Energy Efficiencies—Pounds of Caustic Soda Diffused per Sq.Ft. of Diaphragm per Hour Into Saturated Brine at Varying Decomposition Efficiencies

BY HUGH KELSEA MOORE

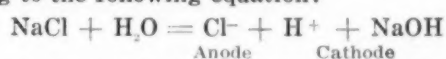
IN 1897 E. A. Allen and H. K. Moore introduced a cell in which was claimed the basic principle of having the cathode unsubmerged in the electrolyte. During the twenty-three years which have elapsed since this time this principle has revolutionized the entire cell industry in the United States.

The first experimental cells built had horizontal diaphragms submerged in a bath of kerosene oil and the caustic as it was formed on the cathode sank to the bottom of the oil and was siphoned off from the bottom. On account of danger of fire, experiments on this line were discontinued and the experiments were conducted having the cathode unsubmerged in the electrolyte but with no oil to balance the static head of the liquor in the anode compartment. Owing to the importance which the unsubmerged diaphragm cell has assumed in the electrolytic industry, it might be well to discuss the fundamental principles involved.

In order that there may be no misunderstanding in regard to the unsubmerged diaphragm cell, I wish to mention that one type of cell represented by the Hargreaves-Bird cell, used for the production of carbonate of soda and chlorine, had an unsubmerged cathode. This type of cell, however, was not available for the production of caustic soda and so far as I know has never been capable of producing caustic soda. In this cell the diaphragm was so impregnated as to prevent the percolation of the electrolyte. The unsubmerged diaphragm type of cells to which I refer allows the electrolyte to percolate through the diaphragm.

Suppose we start with the fundamentals. If a com-

partment filled with salt brine is divided into two parts by a permeable diaphragm and an anode is inserted in one compartment and a cathode in the other and a direct current is passed through, we have chlorine liberated at the anode and caustic soda liberated at the cathode according to the following equation:



If the passage of the current is continued, we obtain an electrolyte constantly decreasing in percentage of salt and constantly increasing in percentage of caustic soda. There will also be a slight increase in the percentage of water in spite of the fact that water is used up in the production of caustic soda. This is due to loss of chlorine which overbalances the loss of water. (See Table I and Fig. 1.)

In Fig. 1 it will be noticed that the term "Decomposition Efficiency" has been used and in order to prevent any misconception of terms, the author's own definitions are included throughout. Therefore this article should be read and criticised in accordance with them and not by any other definitions with which the reader may have previously been familiar.

CURRENT DECOMPOSITION AND ENERGY EFFICIENCIES

A given number of amperes will theoretically produce a given amount of caustic soda in a given time. (See Appendix.) The amount of caustic actually formed, divided by that which should be theoretically formed, is the current efficiency. For example, 303 amp. will produce 1 lb. of caustic per hour. Consequently if we have 1,212 amp. running through a brine solution for one hour and actually obtain 3 lb. of caustic soda, we have

$$3 \div \frac{1212}{303} = 75 \text{ per cent current efficiency.}$$

Decomposition efficiency is the percentage of the salt actually decomposed. Suppose a given sample of caustic effluent takes 6 c.c. of N/10 H_2SO_4 and 4 c.c. of N/10 AgNO_3 , we have $6 \div (6 + 4) = 60$ per cent decomposition efficiency. There is a certain theoretical voltage required for the electrolysis of every electrolyte and any excess of voltage above the theoretical voltage means lost power. For example, we may consider the electromotive force required to electrolyze salt and water into caustic soda, chlorine and hydrogen as 2.3 volts. (See Appendix.)

Now if a cell runs at a current efficiency of 75 per cent with a voltage of 4.1, we have an energy efficiency of $(2.3 \div 4.1) \times 75 = 42.7$ per cent energy efficiency or power efficiency. That is, the energy efficiency is obtained by dividing the theoretical energy required to produce a certain amount of product by the energy actually required to produce that amount of product. Or in other words, the energy efficiency is the percentage of power actually used which is represented by production.

The commercial cell plant endeavors to use a satur-

TABLE I. PRODUCTS RESULTING FROM ELECTROLYTIC DECOMPOSITION OF 26 PER CENT BRINE SOLUTION

(Begin with 100 g. of 26 per Cent Brine Solution)

Per Cent Decom.	—Resulting Solution—					
	G. H_2O Remaining	G. NaCl Remaining	G. NaOH Produced	G. Cl_2 Evolved	G. H_2 Evolved	
0	74.0	26.0	0.00	0.00	0.00	Per Cent NaCl
5	73.6	24.7	0.89	0.79	0.02	Per Cent NaOH
10	73.2	23.4	1.78	1.58	0.04	Per Cent H_2O
15	72.8	22.1	2.67	2.37	0.07	
20	72.4	20.8	3.56	3.16	0.09	
25	72.0	19.5	4.44	3.94	0.11	
30	71.6	18.2	5.33	4.73	0.13	
35	71.2	16.9	6.22	5.52	0.16	
40	70.8	15.6	7.12	6.31	0.18	
45	70.4	14.3	8.00	7.10	0.20	
50	70.0	13.0	8.88	7.89	0.22	
55	69.6	11.7	9.78	8.68	0.25	
60	69.2	10.4	10.67	9.47	0.27	
65	68.8	9.1	11.55	10.25	0.29	
70	68.4	7.8	12.44	11.04	0.31	
75	68.0	6.5	13.33	11.83	0.33	
80	67.6	5.2	14.22	12.62	0.36	
85	67.2	3.9	15.11	13.41	0.38	
90	66.8	2.6	16.00	14.20	0.40	
95	66.4	1.3	16.89	14.99	0.42	
100	66.0	0.0	17.78	15.78	0.44	

*Read before the American Institute of Chemical Engineers, Montreal, June 28, 1920.

ated brine for reasons hereinafter explained. Complete saturation, however, is rarely reached, but it is practical to obtain a brine of 99 per cent saturation or a brine containing approximately 26 per cent salt.

Table I, illustrated graphically by Fig. 1, shows the varying percentages of caustic soda, salt and water resulting from the electrolytic decomposition of a brine solution containing 26 per cent salt. These figures are theoretical, for they make no allowance for the small amounts of water evaporated according to the energy efficiency of the cell, for it will be readily seen that the less the energy efficiency of the cell the greater is the amount of heat generated in the cell and consequently the greater the amount of evaporation, provided of course that this is not compensated for by external cooling. The abscissæ show the per cent decomposition efficiencies and the ordinates the varying composition percentages of salt, caustic soda and water.

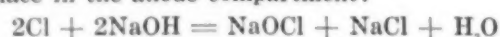
Fig. 1A shows this in a different manner on a three co-ordinate chart, all values lying on the straight line AB. Fig. 1B shows the weights in grams of different chemicals, present or formed, in terms of decomposition efficiencies, obtained by electrolyzing 100 g. of a 26 per cent salt solution. Now as the caustic soda increases in strength there is a tendency for this to diffuse by osmotic pressure into the anode compartment.

DIFFUSION THROUGH DIAPHRAGMS

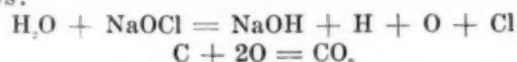
In Table II, illustrated graphically by Fig. 2, will be seen the pounds of caustic which will diffuse through a square foot of diaphragm in an hour with a 26 per cent salt solution from a brine containing different percentages of caustic soda and salt according to the decomposition efficiencies on Fig. 1.

The solid line shows the pounds of caustic per sq.ft. of diaphragm which will diffuse from cold solutions of salt and caustic according to decomposition efficiencies (see Table I) into a 26 per cent brine solution. The temperature of both solutions is 70 deg. F. There is no static head of one solution over the other. While these figures will undoubtedly vary according to the nature of the diaphragm, yet they represent well-known tendencies. These figures are also taken from asbestos such as is used in practice in making diaphragms.

It will be seen from Fig. 2 that the diffusion of caustic into the anode compartment increases very rapidly with the concentration. In order to lessen this diffusion of caustic in cells of the submerged diaphragm type it has been customary to keep the brine in the anode compartment at a higher level than in the cathode compartment, thus retarding the inward diffusion of caustic by the outflow of brine. In addition to the above it has been customary to reduce the concentration of caustic in the cathode compartment by the addition of water. This adds to the evaporating cost, but more than compensates for this by increasing the efficiencies of the cells and reducing the loss of the carbons. I think we can illustrate this loss by the following equations which take place in the anode compartment:



The sodium hypochlorite may be electrolyzed as follows:



It will be seen that this nascent oxygen attacks the carbons with the formation of carbon dioxide and heat. Thus we have a serious waste of carbons as well as a loss of power.

The diffusion of caustic also tends to increase as the temperature rises. See Table IIA, illustrated by the broken line on Fig. 2.

The broken line shows the same factors as the solid line, with the exception that the caustic solution is at

TABLE IIA

Lb. NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies										
Per Cent Decomp. Eff.	Temperature NaOH, 120 Deg.					Temperature NaCl, 74 Deg.				
	11.2	20.0	30.3	39.9	49.9	59.8	69.9	79.6	89.8	
Lb.	0.0254	0.0566	0.0758	0.0967	0.1237	0.1591	0.2113	0.2483	0.3023	

120 deg. F. instead of at 74 deg. F. The brine temperature has been kept at 74 deg. as in the first case mentioned. It will be seen from this curve that a rise in temperature in the cathode compartment increases markedly the rate of diffusion of caustic into the 26 per cent brine solution. To illustrate this tendency still further I submit Table IIB, illustrated by the dotted line in Fig. 2.

The dotted line shows the same factors as the solid line, with the exception that both the caustic and brine solutions are kept at 120 deg. F. It will be seen from

TABLE IIB

Lb. NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies										
Per Cent Decomp. Eff.	Temperature NaOH, 120 Deg.					Temperature NaCl, 120 Deg.				
	10.0	19.4	30.2	40.0	49.8	59.0	70.5	80.3	89.9	
Lb.	0.0451	0.0765	0.0968	0.113	0.147	0.229	0.258	0.293	0.346	

the above that anything which tends to reduce the temperature tends to slow down the diffusion of caustic. Cells with submerged diaphragms should not be insulated against loss of heat.

I might add that the addition of water to the cathode compartment of a submerged cathode cell tends to lower the temperature of the cathode electrolyte and thus also tends to check this diffusion from this cause in addition to checking the diffusion by lowering the concentration of the electrolyte.

INTRODUCTION OF ACHESON GRAPHITE ELECTRODES

It must not be thought from what has been said that the losses caused by diffusion of caustic into the anode compartment ended with those mentioned. In the old days gas-retort carbon was the only carbon available for electrolytic purposes, as Acheson's remarkable product had not then been invented. I might add that, as far as I know, I was the first user of Acheson's graphite in

TABLE II.

Lb. NaOH Diffused per Sq.Ft. of Diaphragm per Hour Into 26 per Cent NaCl at Varying Decomposition Efficiencies

Per Cent Decomp. Eff.	Temperature of Both 74 Deg.												
	5	10	15	20	25	30	35	41	50	60	70	75	85
Lb.	0.004	0.0085	0.013	0.017	0.026	0.037	0.055	0.062	0.080	0.105	0.138	0.142	0.181

electrolytic cells. The retort-gas carbon anodes used prior to Acheson's invention were rapidly attacked by the nascent oxygen liberated on them and the mixture of carbon dioxide and chlorine went to bleach chambers, where the carbon dioxide, having a greater affinity for the slaked lime than the chlorine, liberated chlorine from the bleach already formed. In order that the bleach should not test below 35 per cent available chlorine, it was necessary to skim the carbonate of lime crust formed on the top of the bleach from the bleaching powder underneath.

Thus, you see, this diffusion of caustic caused not only a waste of electrolytic carbons and power but it also

caused a waste of lime, chlorine and labor. There were also other losses, but I will not go into them here. Graphite carbons are also attacked by the nascent oxygen liberated thereon, though not to the same extent that gas carbons are attacked.

Realizing all these difficulties, Moore and Allen attempted to do away with this diffusion by allowing the caustic to run away as fast as formed, either through oil or otherwise.

RATE OF FLOW

In experimenting with different cells it was noticed that sometimes the current efficiency of a cell starting

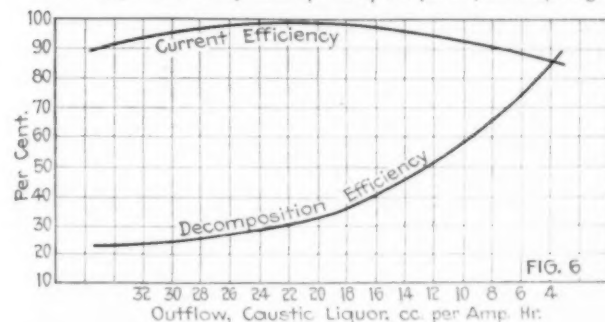
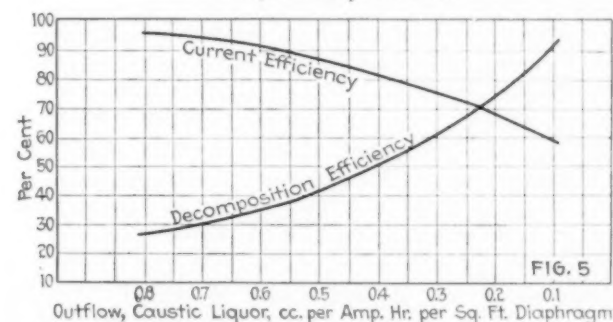
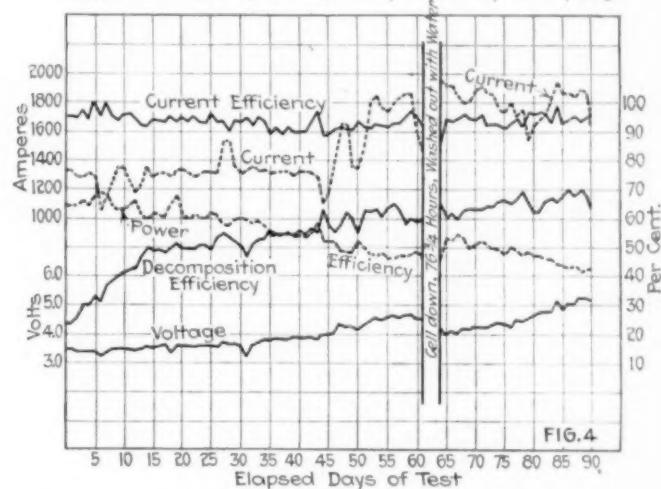
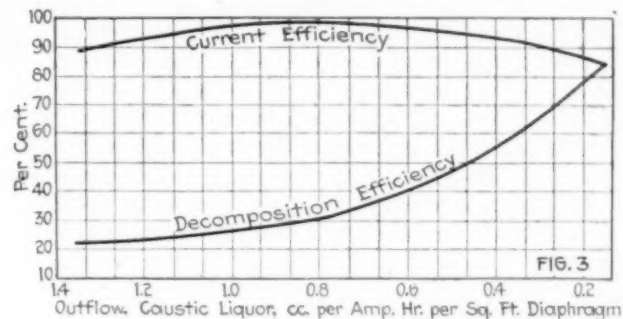
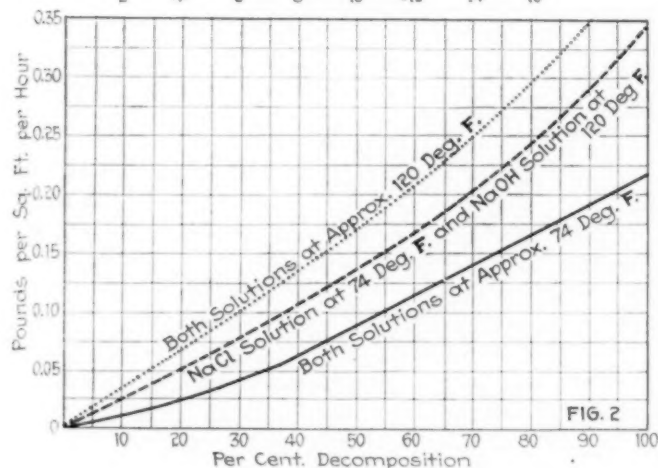
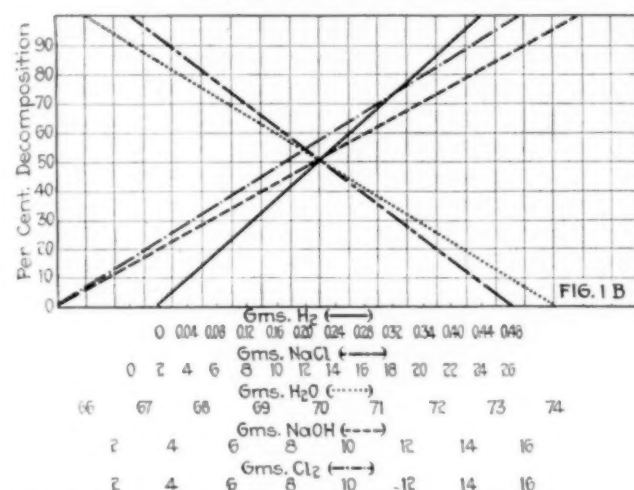
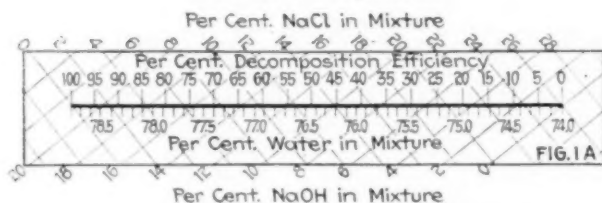
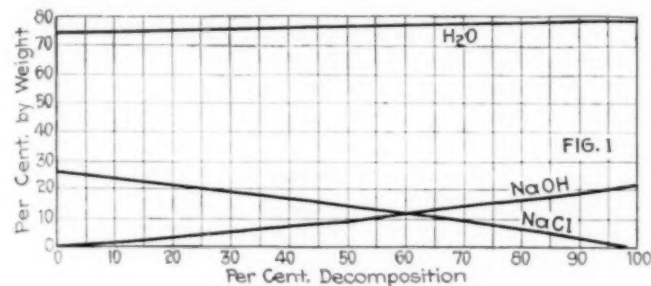


Fig. 1. Composition curves for solution remaining after the electrolysis of 26 per cent brine solution. Fig. 1A. Products resulting from electrolysis of 26 per cent brine solution. Fig. 1B. Products resulting from the electrolytic decomposition of 100 g. of 26 per cent brine. Fig. 2. Diffusion of NaOH from NaOH-NaCl solution through asbestos diaphragm into 26 per cent brine. Fig. 3. Flow of caustic liquor per ampere hour per square foot of diaphragm. Fig. 4. Variations of operation as shown by recording amperes, volts, etc. Figs. 5 and 6. Current and decomposition efficiencies at lower ranges.

up was somewhat lower than after the cell had been running a day or two. It was also noticed that as the cell got older the current efficiency generally rose for a short period, after which the current efficiency gradually declined. These results were not apparent at first because they were obscured by a varying current. In studying the reasons for this we tried to adopt a standard unit of measure by which the operation of two cells might be compared, irrespective of their ages, sizes and the current passing through them. C. B. Barton suggested the measure which we now term as the Rate of Flow and Mr. Barton and Mr. Moore, working independently, made many experiments developing this measure so that they had absolute control of the efficiency of any cell. The pounds caustic solution per ampere hour per square foot of diaphragm was called the Rate of Flow. Since then this term has been broadened to include volume as well as weight. The tabulation and plotting of results showed that when the rate of flow was large the current efficiency was low because of the large amount of chlorine dissolved in the brine, which on passing through the diaphragm with its equivalent amount of caustic and hydrogen re-forms salt and water with the liberation of heat. As the rate of flow diminished the amount of chlorine passing through the diaphragm diminished and the current efficiency rose to its maximum. As the rate of flow continued to diminish the current efficiency diminished and continued to diminish. I should like to be able to submit the original tables and charts illustrating this fact, but cannot do so, as they were destroyed by fire.

Table III, illustrated by Fig. 3, gives an idea of one form of rate of flow—viz., c.c. outflow caustic liquor per amp. hour per sq.ft. of diaphragm.

Table IV, Fig. 4, shows a chart of a cell in which the abscissæ represent consecutive days and the ordi-

TABLE III

Relation Between Rate of Flow in c.c. per Amp. Hour per Sq.Ft. of Diaphragm and Current Efficiency and Decomposition Efficiency													
Rate of flow	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	
Current eff.	90.0	93.0	95.0	97.0	97.5	98.0	97.5	96.5	94.5	92.5	90.0	87.5	
Decomp. eff.	22.5	23.5	25.0	26.5	28.0	32.0	34.5	40.0	47.0	55.5	67.5	77.5	

nates represent the per cent current efficiency, per cent decomposition efficiency, per cent power efficiency and the current in amperes and volts. It will be seen that a chart of this sort requires considerable study before much information is obtained.

Some of the facts shown in Table IV, illustrated by Fig. 4, are shown in Table III and Fig. 3.

It will be seen from the above that we get very regular curves from the apparently heterogeneous matter, as shown in Fig. 4.

Table V, Fig. 5, shows some of the lower ranges. This is only of academic interest, as cells are not supposed to run commercially in a manner to give such results. Of course the results as given in Table V were obtained solely to get some idea as to what effect the continued drop in rate of flow would have.

It will be noticed that Fig. 5 has different characteristics from Fig. 3. In Fig. 5 the cell was run on impure

TABLE IV

Days	Voltage	Current, Amp.	Current, Eff.	Decomp. Eff.	Power Eff.
1	3.44	1,332	95.0	23.0	63.6
2	3.39	1,298	94.5	24.6	64.1
3	3.37	1,282	96.5	30.5	65.8
4	3.39	1,307	93.7	30.1	63.6
5	3.38	1,285	109.0	32.8	68.1
6	3.24	1,036	94.8	30.5	69.4
7	3.34	1,128	99.3	36.9	68.4
8	3.43	1,266	95.1	39.1	63.8
9	3.44	1,346	93.9	40.1	62.8
10	3.47	1,350	95.2	41.3	63.1
11	3.44	1,233	96.3	41.8	64.4
12	3.44	1,164	99.0	43.2	66.2
13	3.48	1,225	92.0	46.6	60.8
14	3.55	1,368	91.5	49.7	59.2
15	3.52	1,282	94.4	48.5	61.8
16	3.55	1,305	93.6	49.1	60.6
17	3.57	1,319	93.1	48.9	59.2
18	3.32	1,282	94.7	49.6	65.6
19	3.58	1,326	93.3	50.8	58.3
20	3.59	1,335	94.9	49.8	60.8
21	3.59	1,301	92.7	49.8	59.4
22	3.55	1,275	94.3	49.8	61.2
23	3.58	1,300	93.1	50.6	59.8
24	3.59	1,321	92.4	50.6	59.2
25	3.59	1,316	96.0	49.5	61.5
26	3.56	1,309	93.1	53.9	60.2
27	3.71	1,531	93.5	54.8	58.0
28	3.61	1,535	90.0	53.4	57.3
29	3.63	1,351	94.0	51.9	59.5
30	3.59	1,309	93.5	50.2	60.0
31	3.16	1,328	93.6	47.0	59.5
32	3.57	1,351	91.1	50.6	58.7
33	3.70	1,320	94.0	52.5	59.0
34	3.76	1,330	93.5	53.2	57.2
35	3.79	1,309	89.4	55.2	54.3
36	3.82	1,307	90.6	54.9	54.5
37	3.80	1,319	89.1	54.1	54.0
38	3.81	1,315	91.1	54.9	55.0
39	3.84	1,296	89.1	54.5	53.4
40	3.86	1,328	90.1	55.9	53.8
41	3.85	1,316	90.1	54.9	53.8
42	3.89	1,306	93.0	56.4	55.0
43	3.82	1,152	97.3	55.2	58.6
44	3.95	1,275	88.7	63.4	51.7
45	3.95	1,197	88.7	58.5	51.8
46	4.01	1,420	90.3	54.9	51.9
47	4.31	1,568	91.4	57.2	48.8
48	4.29	1,634	90.4	66.6	48.5
49	4.29	1,350	90.2	59.0	48.2
50	4.19	1,349	93.1	60.3	51.1
51	4.27	1,509	91.6	62.8	49.3
52	4.40	1,812	90.8	62.5	42.5
53	4.51	1,854	92.9	62.6	47.4
54	4.49	1,765	91.8	61.8	47.0
55	4.53	1,724	91.3	63.8	46.1
56	4.63	1,791	92.1	65.4	45.7
57	4.57	1,842	93.0	62.6	46.8
58	4.64	1,860	95.0	58.0	47.0
59	4.68	1,848	96.6	60.3	47.5
60	4.52	1,598	94.8	58.9	48.2
61	4.50	1,428	90.7	60.5	46.3
Cell down for washing diaphragm.					
62					
63	4.25	1,955	84.9	60.5	45.9
64	4.05	1,905	93.9	60.0	53.3
65	4.10	1,908	93.3	61.2	52.5
66	4.05	1,831	94.8	59.9	53.8
67	4.17	1,798	95.8	62.2	52.8
68	4.19	1,808	94.7	63.0	49.4
69	4.25	1,889	94.2	63.1	51.0
70	4.27	1,918	95.9	63.3	51.7
71	4.25	1,854	92.5	64.1	50.1
72	4.31	1,841	92.8	64.5	49.5
73	4.35	1,755	92.0	65.6	48.6
74	4.35	1,721	90.7	66.0	47.9
75	4.27	1,808	92.5	65.9	49.8
76	4.47	1,690	94.6	66.3	48.6
77	4.46	1,750	91.7	69.3	47.2
78	4.57	1,524	96.4	66.4	48.6
79	4.64	1,644	95.6	61.7	47.5
80	4.72	1,690	96.1	62.2	46.0
81	4.79	1,720	95.7	66.3	46.0
82	4.78	1,841	95.5	66.7	45.0
83	5.12	1,947	98.8	65.2	44.4
84	4.87	1,856	92.7	67.6	43.8
85	5.06	1,852	94.0	69.6	42.8
86	5.05	1,821	94.8	68.4	43.2
87	5.24	1,896	93.8	69.5	41.2
88	5.21	1,861	94.6	67.6	41.8
89	5.15	1,617	95.5	62.7	42.6
90					

TABLE V

Rate of flow, c.c.	0.6	0.7	0.6	0.5	0.4	0.3	0.5
Per cent current eff.	95.5	94.0	91.0	86.5	81.0	75.0	67.5
Per cent decomp. eff.	26.5	30.0	35.0	41.0	50.0	60.0	74.0

TABLE VI

Rate of flow, c.c.	31.0	30.0	27.5	25.0	22.5	20.0	18.0	16.0	14.0	12.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0
Current eff. per cent.	91.5	94.5	96.5	97.5	98.0	98.0	97.5	96.5	95.5	93.5	97.0	91.0	90.0	88.5	87.5	86.5	85.0
Decomp. eff., per cent.	23.0	24.0	25.5	27.0	29.0	32.0	35.5	39.5	44.5	50.5	58.0	61.5	65.5	70.0	74.5	79.5	84.5

brine. It will be seen from the above that while the rate of flow chart is very valuable for comparative purposes when conditions are alike, care must be taken not to use the rate of flow chart determined under one set of conditions to interpret results of cells run under radically different conditions.

Of course neither these results nor the above are absolute, as they may vary within certain limits as will be seen later.

In the above it will be seen that I have given number of c.c. per amp. hour instead of lb. per amp. hour. This is more convenient, inasmuch as one can use a graduate instead of a set of scales.

The application of this kind of chart to the operation of a cell plant is a very simple matter. Suppose, for instance, you found you are going to have available in your cell plant 1,000 amp. and each cell has 20 sq.ft. of diaphragm and that you wished to run at 50 per cent decomposition efficiency. You would look up the rate of flow in c.c. per amp. hour per sq.ft. of diaphragm for 50 per cent decomposition efficiency, which according to Fig. 3 would be 0.46; multiply by 20 and 1,000 and you have 9,200, the number of c.c. per hour which must run through the cell to give you your desired results. If, however, all your cells had the same number of sq.ft. of diaphragm you could make a table like Table VI,

illustrated by Fig. 6, and thus avoid the extra calculation.

Fig. 6 is based on a cell having 26.5 sq.ft. of diaphragm.

Suppose you had a cell plant each cell of which had 26.5 sq.ft. of diaphragm and you wished to run at 55 per cent decomposition efficiency with 1,200 amp. current; you would tell the operator to regulate the levels of the brine in the cells so that he would obtain a flow of 216 c.c. per minute—viz., rate of flow at 55 per cent decomp. = 10.8 c.c.

$$(10.8 \times 1,200) \div 60 \text{ (min. per hr.)} = 216 \text{ c.c. per min.}$$

At this decomposition efficiency the cell should have a current efficiency of 93 per cent. It will be seen from the above curves that a cell plant cannot be regulated by the amount of brine fed to the whole plant, for the cell which has too great a flow will have a low efficiency as well as the cell which has too small a rate of flow. To run a cell plant properly each cell should be regulated as to its rate of flow individually. In a commercial plant you have a mixture of cells whose ages since renewal of diaphragms, carbons, etc., may vary all the way from one day to 300 days. In our plant of 550 cells the ages vary from one day to 180 days.

Automatic Cooking Control for Chemical Pulp*

By C. H. ALLEN

SULPHITE pulp should be cooked automatically for three principal reasons, as follows: (1) Production will be increased; (2) quality will be improved; (3) the steam load on the boiler house will be more uniform.

The automatic control which I shall describe does for each charge of chips what a good cook tries to do but can never do, because, in the first place, the apparatus he is using places a practical limit on his control, and secondly, he cannot be everywhere at once and think of everything at the same time.

The Allen automatic cooking control system consists essentially of a power-driven steam valve electrically connected to a steam flow meter on the digester steam line, an automatic relief valve, and relief strainers that do not plug. It also includes the automatic separation of relief gas and liquor.

The steam apparatus can be set to maintain any constant or varying steam flow curve. Temperatures within the digester are proportional to the rate of steam input. The control apparatus therefore can be set to give any desired temperature curve.

Cooking automatically does not necessarily mean that all charges of chips will be steamed on the same steam curve. In practice, where the strength of the acid and quality of chips are reasonably constant the same steam flow curve should be used on all digester charges; but in cases where the strength of acid and quality of chips vary widely from cook to cook better results may be obtained by varying the form of the steam curve to suit changing conditions.

These changes in the steam flow curve are very readily and quickly made. The steam curve element of the control system is a small thin plate of copper having an

insulated hole; it is slipped over the chart spindle of the steam flow meter clock. The periphery of this piece of copper at any point represents the rate of steam it is desired to carry at that particular instant.

Once the cook is started it needs no further attention until blowing time, and further, when a cook is started it is known beforehand when it is going to blow, within a few minutes. The reason for this is that it takes a certain and very definite quantity of steam to cook a cord of chips, and steam is metered into the digester at a predetermined rate. The cooking time may be shortened by steaming at predetermined higher rates, and lengthened by steaming at predetermined lower rates. It has been proved that other conditions such as will occur from day to day do not affect the cooking time except to a negligible degree. When the digesters of any one mill are steamed automatically, the proper spacing out of the blowing time follows as a natural and inevitable result. If as sometimes happens after blowing a digester a small amount of repairs are found necessary to the blow valve or piping, which delays the time of starting to cook the next charge of chips, the cooking operation can nevertheless be finished on schedule time by adjusting the control apparatus to maintain a higher steaming rate.

The automatic relief valve can be set to maintain any pressure it is desired to carry within the digester. The relief valve stem is operated by a diaphragm which carries digester pressure on one side and is counteracted by a spring on the other. The diaphragm and spring are made large so that the resistance due to the sticking of the valve stem in its packing is practically negligible in comparison with the forces which tend to actuate the valve. When cooking by hand a good cook tries to open his relief valve by very small amounts at each adjustment and just enough to hold the digester pressure against his steam valve opening. If he happens to open too wide the strainer plugs, it is then necessary to shut off steam, blow back the strainers and start over again. The automatic valve cracks open

*Read before the Technical Association of the Pulp and Paper Industry at the fall meeting in Saratoga Springs, N. Y., Sept. 1, 1920.

by exceedingly small increments. It is always open to the correct amount and instantly responds to changes in pressure too small for a cook to detect even if he happened to be trying to do so.

The strainers used in connection with the control apparatus are of two different designs, one being adapted for use under the cover and the other in the digester neck. The cover strainer, so called, is somewhat similar in appearance to other strainers in general use. It consists of a bronze internal framework and an outside covering of thin perforated lead. The neck strainer so called is made of perforated hard drawn lead. It is cylindrical in form and wide open at both ends. The outside diameter of this strainer is approximately 1½ in. less than the internal diameter of the digester neck. In short, the strainer is a perforated lead bushing fitting loosely in the digester neck. In operation the relief gas and liquor flow from within the strainer outwardly to the space between the bronze sleeve in the digester neck and the strainer, thence through the digester neck and through a pipe of suitable size to the automatic relief valve. This is a stationary

uniformity of quality than is the case where steaming is left entirely in the hands of the attendant. Temperature recorders give only a rough indication of the steaming rate. It is easily possible to produce a very smooth temperature curve and a very erratic steam flow curve at the same time.

Temperature recorders are sluggish and slow to respond to the throttle valve. They do not indicate the rate of steam input at any instant. Changes in the

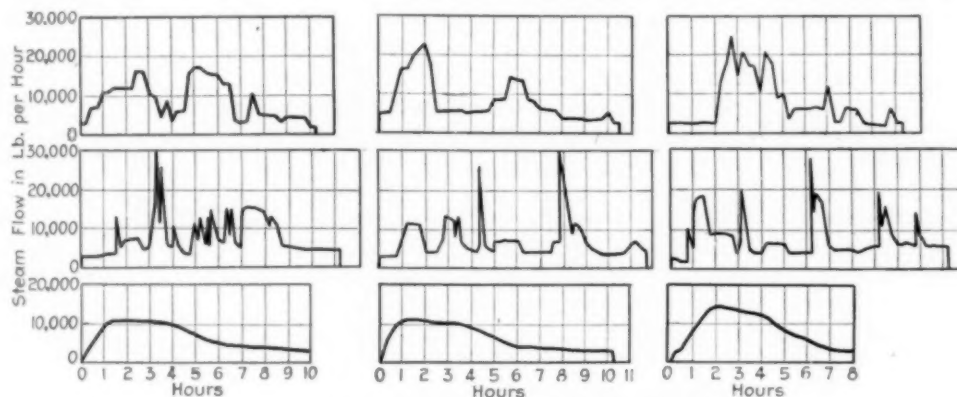


FIG. 2. STEAM FLOW TO DIGESTER METER RECORDS
Top—Hand control. Middle—With well-known regulator. Bottom—With Allen automatic control system.

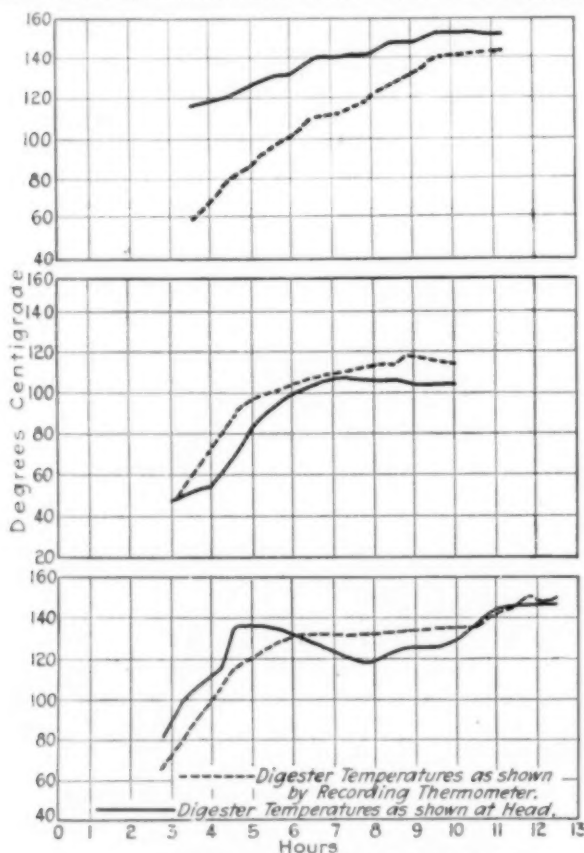


FIG. 1. DIGESTER TEMPERATURE RECORD

strainer—i.e., it is not removed when the digester is being refilled.

In the cooking of sulphite pulp many mill superintendents seek to have their cooks follow predetermined temperature curves. This practice represents an effort in the right direction and results in a somewhat greater

quantity of steam pouring into the digester can be detected by means of the temperature recorder only after the lapse of considerable time.

Moreover, the temperatures at any two points within the digester are seldom the same. This fact is illustrated by the three sets of temperature records shown in Fig. 1. These are records of actual cooks. The dotted line in each case is the temperature in the side of the digester. The solid line is the temperature in the head.

Violent changes in the steam rate of short duration cause scarcely a ripple in the temperature curve; however, spasmodic and violent changes in the rate of steaming do cause non-uniformity of product. Spasmodic and violent changes in the rate of steaming also affect the economy of steam plant operation disastrously.

A sulphite cook, whose experience in cooking sulphite extends back over a period of seventeen years, once said to me: "I never steam two digesters alike, and no two cooks steam digesters alike." This man spoke the truth, as the evidence of the temperature records indicates.

In Fig. 2 the first three curves are the steam flow meter records of three cooks steamed by hand. The next three curves are the actual steam flow meter records of three cooks steamed with a well-known regulator; these are even worse than the records from hand control, though to be fair it should be said that this regulator produces a very smooth pressure curve. However, the degree of smoothness of the pressure curve is no indication of quality or the cooking time.

The last three curves are actual steam flow records taken from the same digester when steamed automatically. The first two curves were produced with the apparatus set for a 10½-hr. cook, the last curve with the apparatus set for an 8½-hr. cook. The quality of sulphite produced by these automatically maintained steaming rates was excellent.

In general it may be stated that the form of the steam curve determines quality, and the average rate of steaming determines the length of the cook.

Steel Rails From Sink-Head and Ordinary Rail Ingots—III

Various Physical Tests, Metallographic Examinations and Chemical Surveys, as Usually Performed, Were Made Upon All the Rails Under Examination—Comparison Rails Performed Much Better Under the Drop Test, and Service Tests Report Less Abrasion*

BY GEORGE K. BURGESS†

MECHANICAL TESTS

THE mechanical tests included the ordinary drop test made on the first 5-ft. piece below the top of the ingot showing physically sound steel. For the Hadfield rails this location was, in all but two cases, determined by the junction of sink-head with the ingot proper. The test was made in the usual way by dropping a 2,000-lb. tup from a height of 18 ft. upon the head of the rail, which was supported at two points 3 ft. apart. This test gives record of permanent set, elongation on the base and the number of blows required for the destruction of the rail.

The 6-in. test pieces (B, C, D, etc.—Figs. 1 and 2)[‡], the drop test pieces and the specimens from the "M-A" position were examined for ultimate tensile strength, using a 2-in. test length, yield point, elongation, reduction of area, and hardness of Brinell and scleroscope. All specimens for the tension tests were cut longitudinally.

Method of Expressing the Results of Mechanical Tests. It is thought best to express measurements, such as yield point, ultimate tensile strength, elongation, etc., in terms of the average and average deviation from the mean.

The deviation of a single observation is the amount by which that observation departs from the mean or average value. By subtracting each observation from the mean without regard to sign, and averaging these, the average deviation from the mean is obtained.

When using the usual method of expressing results of this kind in terms of maximum and minimum values, undue emphasis is placed upon the occasional widely divergent figure, while the very close agreement that may exist is not brought to light.

Ultimate Strength and Yield Point. The ultimate strengths of the steel in rails from the H and M ingots are given in Table VIII* and are of the same order of magnitude—about 125,000 lb. per sq.in. For the thirty-five sink-head ingots the non-uniformity, expressed as the average deviation from the mean for values at the "A," "B," "C," "D" and "E" positions, is somewhat greater than for the comparison ingots, except for the "A" position, at which the results are erratic.

If we consider the ultimate strength throughout the length of the ingot, we note for the sink-head ingots there is practical uniformity down to the "E" position, while in the comparison ingots there is an abrupt increase in ultimate strength from the "A" to the "B" position and then a gradual falling off until the bottom of the ingot is reached, where at the "F" position the ultimate tensile strength is about 9,000 lb. per sq.in. less than the maximum at "B."

If the comparison ingots are studied by groups corresponding to heats, it may be shown that the ultimate strength of each group may be distinguished from the others. Thus groups M1 to M5 and M6 to M10 run closely parallel through the ingot, with M6 to M10 having slightly higher ultimate strength. Group M11 to M15 is characterized by the abnormally high value approximately (130,000 lb. per sq.in.) in the "A" and "B" positions.

The yield point shows, in general, characteristics similar to the ultimate strength; for the former, however, there is a somewhat greater uniformity throughout the ingot for all types, and for the ingots of a given group. The sink-head ingots have a slightly higher yield point (62,370 lb. per sq.in.) than the comparison ingots (61,370 lb. per sq.in.). For the three groups of the latter there is a falling off throughout the length of the ingot from approximately 64,000 lb. per sq.in. for B rail to 59,000 lb. per sq.in. for F rail (as for the ultimate strength), while for the sink-head ingots the yield point remains practically constant throughout.

Elongation and Reduction of Area. The distribution of ductility, as measured by elongation in tension test pieces from rails through the length of the sink-head ingots, is somewhat more uniform than for the comparison ingots. Elongation is practically the reciprocal of the tensile strength.

The average elongation of the rails from the sink-head ingots is 13.8 per cent, of the comparison ingots 13.6 per cent; the reduction of area for the former type of ingot is 24.38 per cent, for the latter type 25.78 per cent with a range of 21.73 per cent at "B" to 31.68 per cent at the "F" position. There are also considerable differences among the three groups of comparison ingots.

Hardness. The scleroscope hardness numbers do not appear to have any significance in defining any differences in qualities or properties in the steel of the several ingots. The material from the sink-head ingots has an average hardness of 31 while the steel from ingots cast in the usual manner has an average hardness of 32.

The Brinell numerals are, as would be expected, fairly closely proportional to the ultimate strengths and they appear to follow even more exactly the yield points. Whether or not there is any definite relation between carbon segregation and Brinell numerals appears difficult to say. The holes in drilling for the former are $\frac{1}{2}$ in. in diameter and not always exactly coincident in location with the Brinell impression. In a general way one would expect the two to bear some relation to each other. The rails from the sink-head ingots had an average Brinell hardness of 260 (deviation ± 8) while the rails made from ingots cast with the small end uppermost without sink-heads had a Brinell hardness of 250 (deviation ± 6).

*For Parts I and II see CHEM. & MET. ENG., vol. 23, Nos. 19 and 20, Nov. 10 and 17, 1920, pp. 921 and 969.

†Chief division of metallurgy, Bureau of Standards.

‡See pp. 921 and 924.

§See p. 971.

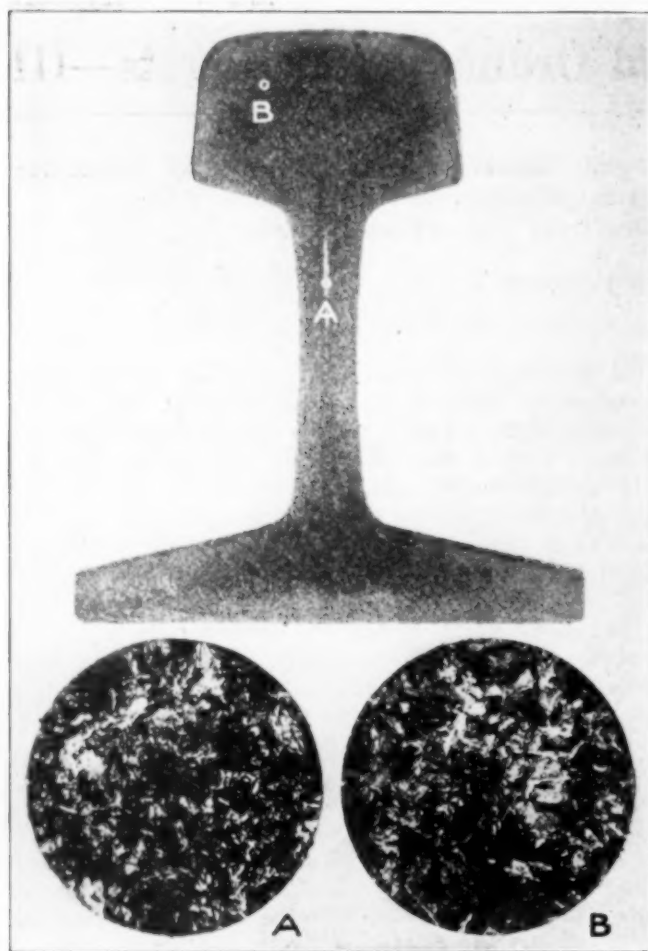


FIG. 7. RAIL H16-A

Sulphur print shows slight segregation in rail from upper part of ingot.

A—Shows eutectoid structure of slightly segregated streak in web.

B—Average fine grained structure, pearlite with a very slight trace of ferrite.

Drop Tests. In the drop tests, blows were given on head of rail to destruction, the deflection was measured for each blow, the elongation for each inch over 6 in. and the total elongation noted.

The drop-test piece was taken from near the top of the ingot and in each case was the first 5-ft. length of rail immediately after reaching physically sound steel—i. e., free from pipe—and in the case of the rails from sink-head ingots also below the bottom of the sink-head. Of the fourteen comparison rails none broke under four or five blows (six rails were nicked and broken after the fourth or fifth blow), while for the thirty-five Hadfield rails the range was two to seven blows, there being nine of four blows, and four of three blows; only twenty-two, or 63 per cent, of the rails from sink-head ingots withstood four or more blows. The ductility as measured by the deflection and elongation is also somewhat greater and more uniform for the comparison rails.

Recalling the greater uniformity of the sink-head over the comparison ingots as shown in nearly all other mechanical tests, in less segregation, greater homogeneity as shown by sulphur prints and etching, less amount and variability in discard to sound steel, the question of the significance and interpretation of the drop test may, it would seem, be raised with propriety. The greater ductility and more uniform behavior under the drop test of the steel from the comparison ingots

would appear to be due more to the chemical composition and especially to the nickel and chromium content of this Mayari steel than to any factor traceable to manufacture, which in the case of the comparison ingots is seen to divide them sharply into three groups of very distinct physical characteristics—each a heat—which fact the drop test is unable to reveal.

METALLOGRAPHIC TESTS

A sulphur print, light etching, and two photomicrographs at 100 diameters were taken of each test piece, examples of which are given in Figs. 3, 5, 6,⁷ 7 and 8 (micrographs are here represented at 35 diameters).

Photomicrograph A was taken at upper part of web, B corresponds approximately with "O" position of Fig. 3. These tests were also made on sections of the 5-ft. pieces of the M-x, M-a and H-a rails to accompany the determinations of discard for chemical segregation.

The metallographic tests throw additional light on the question of segregation and soundness, and especially with reference to the presence of slag inclusions, streaks and seams. They also furnish evidence as to the uniformity of the operations in the rolling mill; although there appears also to be a distribution of structure for each ingot characteristic of its manufacturing processes preceding the rolling.

⁷See pp. 969 and 974.

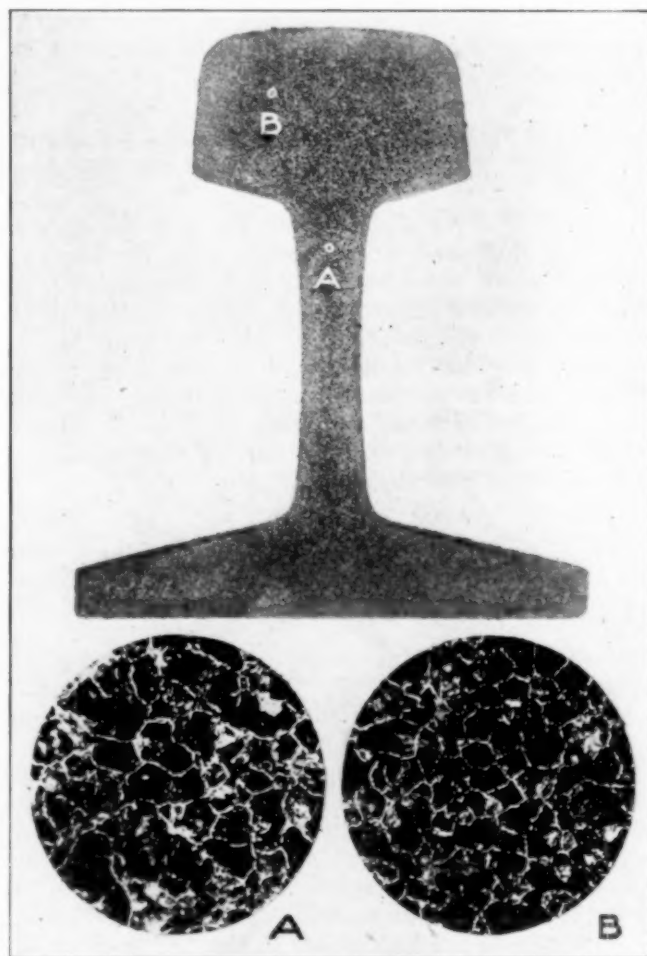


FIG. 8. RAIL H16-E

Homogeneous rail from bottom of same ingot yielding rail H16-A (Fig. 7).

A—Moderately fine grained structure, with a thick ferrite network.

B—Average fine grained structure, pearlite with a ferrite network.

The smoothness and evenness of tone of the sulphur prints of all rail sections from the Hadfield sink-head ingots, which are characteristic of the lot (Figs. 7 and 8), even from sections in the drop-test portion near the top of the ingot, is in striking contrast to the markedly irregular sulphur prints from comparison rails (Fig. 3)⁸, except for a few below the center of some of these ingots. Most of the rails from the Maryland ingots show very pronounced irregularities in terms of the sulphur prints, some of them from bottom of ingot showing well-defined pipes (Figs. 6 and 7).

As to the microstructure of the steel, here again the sink-head ingots show much the greater uniformity. This is especially true for the upper portions of the ingot, where differences would be expected.

The rails from the comparison ingots below the segregated area have about the same structural characteristics as the sink-head, except that for many of them the ferrite network is less pronounced and in some cases almost absent. The rolling and finishing temperatures of the ingots were not widely different and do not appear to play any considerable rôle in determining differences of structure. The manganese content, usually somewhat higher in the Hadfield ingots, apparently acts to accentuate the sharp, definite boundaries of ferrite surrounding the pearlite grains.

Sink-Head Ingot H37. Sink-head ingot H37 was cut in halves at Sheffield and Sir Robert Hadfield reports: "The whole of this ingot could be worked into rails after cutting off 10 per cent discard. The ingot is perfectly sound and represents the average quality of the whole of the thirty-six ingots sent to be rolled into rails."

"The capacity of the sink-head cavity of this ingot

was 8,125 c.c., and the percentage of settling by weight in pounds—that is, of the total weight of the ingot—was 2.58 per cent. The weight of the material which passed from the head portion into the ingot itself was about 130 lb. This ingot was selected because it showed the lowest cavity percentage—i.e., 2.58 per cent."

Sink-Head Ingot H32. Sink-head ingot H32 was cut in halves at the Bureau of Standards. A photograph of a sulphur print of longitudinal half section of the ingot is shown in Fig. 9. Figs. 10 to 13 show the location of drill holes for chemical analyses of this ingot, as well as the results of the analyses. Only



FIG. 9.

Sulphur print of half-section of sink-head ingot H32.

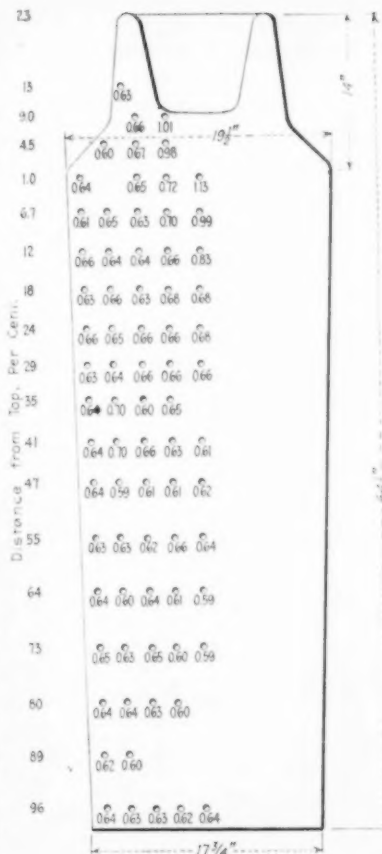


FIG. 10. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32

Showing percentage carbon of various ingot positions.

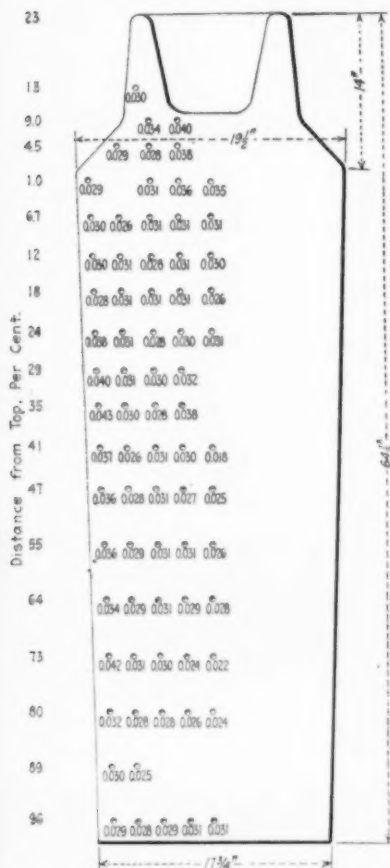


FIG. 11. DIAGRAM OF SINK-HEAD SPLIT INGOT NO. 32

Showing percentage phosphorus of various ingot positions.

carbon, phosphorus, silicon and sulphur surveys were made, as the rail analyses indicated that there was no appreciable segregation of manganese in similar ingots. The results indicate that with about 9 per cent discard, steel free from piping and appreciable segregation is obtained.

Carbon showed a high degree of segregation (0.68 to 1.13 per cent), but it will be noted that this is confined to extreme upper portion of the ingot. The high carbon content at this point is probably due to the fact that the steel in the top part of the ingot absorbed carbon from the charcoal used to keep the ingot hot on its upper surface while cooling.

⁸See p. 969.

average abrasion of the Hadfield rails was 1.16 sq.in. and that of the ordinary rail 0.78 sq.in. None of these rails failed.

"In September, 1915, the Maryland Steel Co. rolled forty-six No. 1 and sixty-one No. 2 P. S. 100-lb. rails (0.33 track-miles) from imported Hadfield sink-head ingots and at the same time rolled fifty-three No. 1 and four No. 2 P. S. 100-lb. rails (0.18 track-miles) from its own ingots for comparison. The forty-six No. 1 Hadfield and fifty-three No. 1 Maryland Special rails were laid on Nov. 26, 1915, in the eastward passenger and freight track on the 5 deg. 30 min. curves between Spruce Creek and Union Furnace, Middle Division, and removed on Oct. 23, 1916. The sixty-one No. 2 Hadfield and four No. 2 Maryland Special rails were laid on a 2 deg. curve in the eastward low-grade track, Philadelphia Division, west of M. P. 69, and are still in track. The average abrasion of the No. 1 Hadfield rails was 0.42 sq.in.; that of the Maryland Special rails 0.37. The rail on low grade was still in track on Oct. 31, 1919; abrasion was then 16.1 per cent for Hadfield and 9.7 per cent for Maryland Special.

"There have been no failures of Hadfield rails or of the Maryland Specials.

"There is evidently no economy in the Hadfield process as regards wear, and it would require a much more extended trial to determine the relative freedom from failure."

The Maryland rails may owe their less abrasion to their content of nickel and chromium. It would appear to be unfair to draw any general conclusions as to performance in service from so few rails as this investigation furnished, although it would not be expected that the Hadfield type of sink-head ingots would furnish any rails showing structural defects.

The service results, showing no failures to date, in the few rails of this investigation cannot be considered conclusive one way or another.

It would be of the greatest practical importance in tracing statistically the origin of rail failures, if, in the reports to the rail committee of the American Railroad Engineering Association, they be grouped with reference to their position in the ingot, and in addition the steel manufacturing process be reported, at least briefly, by such notations as raising steel capped with plates; quiet steel deoxidized with x ounces of aluminum per ton; etc. If then it be found that for a given kind of steel there is a greater or less tendency for certain types of failure to predominate or to exist in certain definite regions in the ingot, corrections could be made intelligently in the manufacturing process.

The present investigation indicates very strongly that one should expect the four types of steel and two types of ingot examined, in view of the sharply differing characteristics, to behave differently in service.

The results obtained indicate a decided superiority of the sink-head ingots over the comparison ingots as

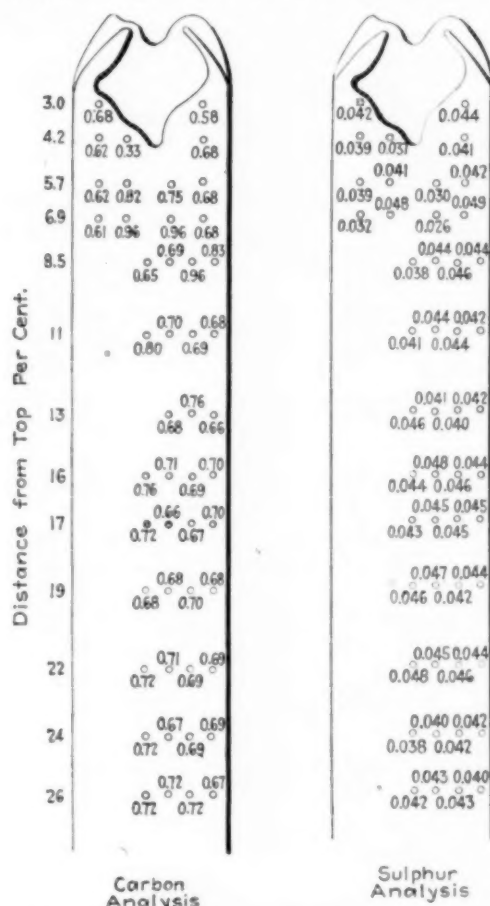


FIG. 15. CARBON AND SULPHUR SURVEY FROM TOP BLOOM H5

made of three grades of steel (Tables XI and XII)", although the sink-head ingots suffered from the disadvantage of having gone cold before rolling. The Hadfield type of ingot required a total discard of only 18.4 per cent on the average (13 per cent top discard to eliminate piping and segregation above 12 per cent), while the average ingot of the ordinary type for rails require a total discard of 43.9 per cent (26 per cent top discard), with great variations dependent upon the furnace and ingot practices. The comparison ingots

"See pp. 972 and 973.

FIG. 14. SULPHUR PRINTS OF SPLIT BLOOMS (BASE)
Longer piece, top bloom from M10. Shorter piece, top bloom from H5.

TABLE XIV. MECHANICAL AND CHEMICAL PROPERTIES OF THE SINK-HEAD SPECIAL (NICKEL AND CHROMIUM) INGOT

Rail	Tension Tests				Hardness		Chemical Analysis at "O"								
	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elong. Per Cent in 2 In.	Red. Area Per Cent	Brinell	Sclero-scope	O	M	Seg.	Mn	Per Cent P	Si	S	Ni	Cr
H38-A	70,030	142,725	12	18.79	274	33	0.741	0.741	0.0	0.91	0.024	0.179	0.018	0.19	0.10
H38-B	70,700	143,400	11	18.59	298	32	0.731	0.729	-0.27	0.95	0.027	0.177	0.019	0.19	0.10
H38-C	70,950	143,450	12	18.54	318	29	0.728	0.735	0.96	0.93	0.026	0.179	0.018	0.19	0.12
H38-D	71,445	143,300	11.5	18.38	283	33	0.734	0.726	-1.09	0.94	0.027	0.185	0.018	0.18	0.10
H38-E	70,830	142,250	10	21.00	287	31	0.731	0.730	-0.14	0.96	0.025	0.180	0.019	0.19	0.11
Average	70,791	143,025	11.3	19.06	292	32	0.733	0.732	0.0	0.94	0.026	0.180	0.018	0.19	0.11

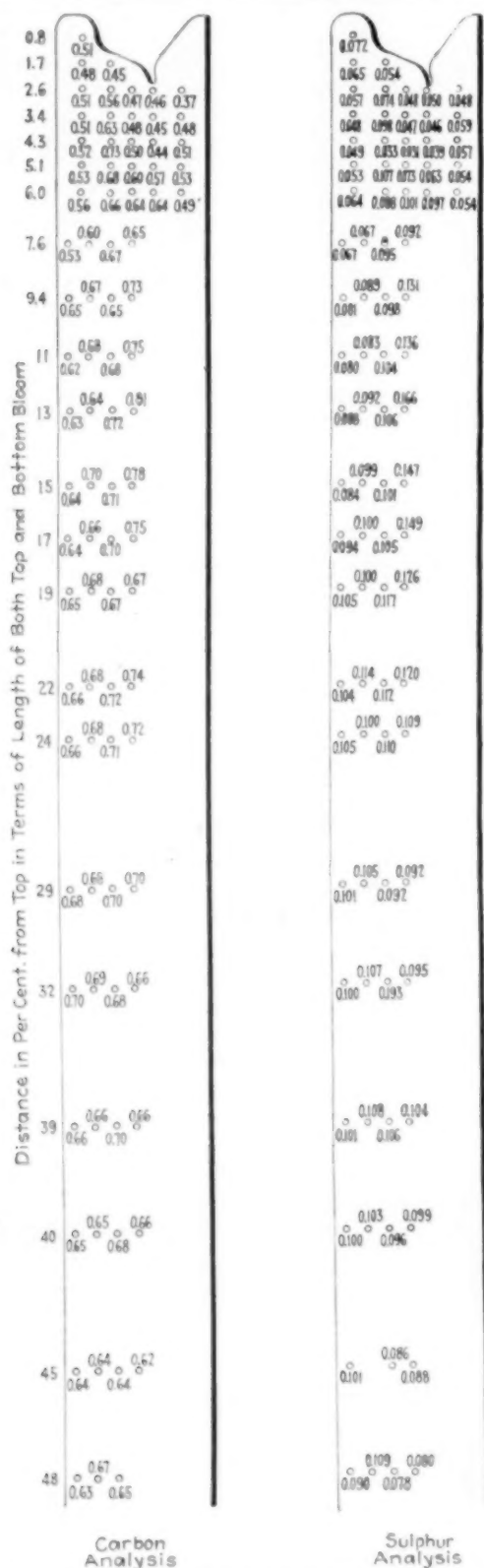


FIG. 16. CARBON AND SULPHUR SURVEY FROM TOP BLOOM H10

from heat M1 to M5 of non-deoxidized rising steel, chilled on top of ingot by cast-iron caps, required excessive discard to eliminate positive segregation at the top and negative segregation at the bottom of the ingot, the latter often accompanied by dangerous pipes.

The second heat (ingots M6 to M10) made of rising steel deoxidized with aluminum in the molds and the ingot tops of which were cooled with water, required the least total discard of the three heats. It was more subject to piping and less to segregation than the first heat of ingots made in the usual manner.

The third heat (ingots M11 to M15), made of quiet or "killed" steel, was not chilled on top with water or caps and was deoxidized with aluminum in the molds. The ingots of this heat required an intermediate amount of total discard when compared to the first and second heats; this heat was the only one for which a greater top discard was required to eliminate piping than to eliminate segregation above 12 per cent. One of the ingots of this third heat contained a small pipe at the bottom and all the rails from the middle and bottom of the ingots showed high negative segregation.

The distribution of physical properties throughout the length of each ingot is characteristic not only of the type of the ingot and the casting practice but also of the state of the steel when cast.

It has been established in the foregoing that after removal of the top discard of 13 per cent, the Hadfield type of sink-head ingot is free from piping and undue segregation. The ordinary type of ingot, cast small end up without sink-head as is usual for rail ingots, requires an average top discard of 26 per cent and the remainder of the ingot is liable to contain enclosed piping and excessive segregation. Defective rails, from the middle and bottom portion of the ingot, are not certainly detected by means of existing rail specifications, and as a result of this uncertainty rails containing pipes or excessive segregation may get into service with disastrous results.

The surface condition of the rails from the sink-head ingots was not as good for the ordinary ingots, but this is not considered an essential characteristic of rails from such ingots.

The markedly differing characteristics of the three heats of Maryland ingots leads one to raise the question whether or not it might be advisable to specify, at least in some degree, the methods of steel manufacture or of ingot practice for rails and similar products on which the safety of the traveling public depends.

While it is not claimed that the use of the sink-head process for the manufacture of ingots will solve all rail problems, it is maintained that its adoption would be a step in the right direction in view of the present heavy casualties and property losses on American railroads. The necessary changes in mill operations, it is believed could be made without too great difficulties.

Tanks and Pipe Lines as Causes of Accidents*

A Study of the Hazards Involved in the Use of Storage Tanks and Pipe Line Distributing Systems in Chemical Plants — Safe Methods for the Construction, Cleaning and Repairing of Underground and Overhead Tanks and Pipe Lines

BY HOMER A. HOFFMAN†

PIPE lines and tanks are an important factor in the distribution and storage of liquids in a chemical factory and not infrequently we hear of an accident due to a break in the line, the overflowing of a tank, or persons becoming unconscious while in a tank, and even explosions as the result of directing a line into a tank other than the one intended. Although this is but one of the hazards of the chemical industry, it is one to which considerable attention may be given.

Our first consideration is the liquid to be handled, what are its reactions, its specific gravity and viscosity. In the selection of pipes and tanks it must be known in what way they will be affected by the liquid handled, what will be the probable life of the pipe or tank and will it in any way change the structure or give off impurities that will affect the liquid.

MATERIALS OF CONSTRUCTION

The field to select from is large and various, so that generally a choice can be made to fit the case. For instance, cast iron does very well for sulphuric, but not for tannins, which are best handled in copper- or brass-lined tanks and pipes. A few of the materials may be enumerated, such as stoneware, earthenware, monel metal, which satisfactorily resists acids and alkalis, aluminum for acetic acid, glass-coated or enameled cast iron, hard rubber and wood, all of which are used to meet certain conditions. The choice of woods are cypress, redwood and long-leaved pine.

For high-pressure pipe where the liquid necessitates costly material, cast iron or pipe of sufficient strength and lined with particular material is used. Connections on all high-pressure lines must be flanged, and valves are to be of a reinforced type. It will be found advantageous to use replaceable seats in such valves.

DISCUSSION LIMITED TO STORAGE TANKS AND DISTRIBUTION PIPING

Under location, it may be well to classify tanks for storage and piping for distribution. No attempt will be made to discuss the types engaged in processes.

Tanks used for the storage of flammable liquids should be placed so as to conform to the requirements of the National Fire Protection Association or other similar body. As these come under another subject, "Fire Explosions, etc.," they will not be given here. For non-flammable chemicals the tanks acting as distribution centers may be placed above ground or overhead and under ground.

CONSTRUCTION OF UNDERGROUND TANKS

Underground tanks may be set in vertically or horizontally, the latter being preferable for those of large

capacity. A well or pit of concrete should act as a receptacle, the space between the pit walls and tank should be wide enough to allow the passage of a man at any point and the tank should be mounted about 15 in. above the pit bottom. This will allow for an easy inspection and room for workmen making repairs, and will provide proper ventilation about the tank. If the tank is in too close quarters the painting of it is often overlooked and its life will not be as long as expected.

The pit will withstand the action of fumes and acid far better if lined with asphalt, tar or one of the like preparations on the market. The latter as a rule contains a binder of asbestos or other material which prevents in cracking or scaling off. A stationary ladder should be at the pit opening so a person may emerge without delay. When a person is working in the pit a sign to that effect should be hung outside, or, better still, a man should be stationed above the pit.

Gratings are not suitable pit covers, as they allow water and dirt to accumulate in the pit, but if they are used, drainage should be provided for. Sliding covers or sectional lids are generally used for the purpose.

With a tank in a pit of this type a leak can easily be located and in case of a burst or overflow the contents can be recovered and repairs can be made without removing the tank. Tanks placed so should not exceed 10,000 gal. capacity and should be at least 2 ft. below the ground level or floor surface. All gages should be placed where they can be clearly read, and all control valves, cocks, etc., should be fitted with long stems that can be turned without entering the pit and have on them locks or warning signs if any danger exists or they are likely to be tampered with. Vent pipes should end in a receptacle for that purpose.

DISTRIBUTION FROM UNDERGROUND TANKS

Distribution from underground tanks necessitates pumps or compressed air, the latter being quite satisfactory for a good many liquids. Any difficulties in distribution are outweighed by the fact that there is no drip, splash or spray to contend with, material would not be lost in case of a burst, valves are above the tank, the tank is not easily reached by fire and in plants where space is limited it is out of the way.

LOCATION AND CONSTRUCTION OF OVERHEAD TANKS

Overhead tanks present more problems. The location is an important consideration. If placed over passageways, as is sometimes done, a drip pan of sufficient size, with a drain to a sewer or emergency tank, must be provided to carry off any liquid from a leak, overflow or burst. When placed in or on a building, it must be known that the floor, roof or building will not be overloaded when the tank is full.

*Delivered before the Chemical Section at the Ninth Annual Safety Congress of the National Safety Council, Milwaukee, Sept. 30, 1920.

†Safety Engineer, Monsanto Chemical Works, St. Louis, Mo.

Wood is used to a large extent for overhead tanks, and as the woods previously mentioned will resist the action of sulphuric and acetic acids of 20 deg. Bé., many of them, mostly of the open type, are found in chemical works. The failure of wooden tanks is often caused by the corrosion of flat hoops, the inner side of which cannot be seen and any defects noted. It is advisable therefore to use only round hoops, which can be gone over from time to time. Wooden tanks should not be allowed to dry out, but if such is the case the hoops may be tightened before being put into use again.

Dry rot is another cause of failures, so periodical inspections should be made. There must be as small a surface as possible in contact with other materials.

Pressure tanks should be tested over pressure before being put into use. Thus a tank car of liquid chlorine would be subjected to a pressure of about 300 lb. per sq.in. Such a tank will receive jolts, so it must be heavily insulated and the dome fittings incased in a hood. Switchings and siding from which such tanks are being loaded or unloaded should have a warning or lock on the switch.

In the case of all aboveground or overhead tanks a hoseline with a stream sufficient to drown a burst, and an emergency box containing gloves, goggles, safe clothing, etc., should be kept in the vicinity.

A runway or platform should be built over the tops of closed tanks so that valves and cocks can be reached from above or from one side. The chief advantage of the overhead tank is that distribution from it is by gravity.

SAFE METHODS FOR CLEANING AND REPAIRING TANKS

Care in cleaning and repairing tanks is very important, and rules governing such operations should be strictly enforced. The importance of this may be illustrated by an occurrence at our plant which took place before the safety idea was recognized. The work on the particular tank was a welding job and before consulting the superintendent or chemist to ascertain if the tank had been properly ventilated, the welder injected his torch into the tank, causing an explosion which resulted in his death and injury to his helper, who had expected something of the sort and was making a getaway.

On another occasion a foreigner who was employed as a leadburner was found doing a job on a tank that had not been inspected. When asked how he knew it was safe to start, he replied: "He is all right. I try him first with my torch, he no blow up."

It is well to have steady crews to do such work as cleaning and repairing tanks. The accepted method of cleaning tank cars may well be applied to all other large closed tanks. The work of cleaning such tanks should be under the direction of a superintendent and as nearly as possible accomplished from the outside. This can be accomplished by removing the cleaning blank and opening all drains, after which a 2½-in. hose fitted with a curved 2-in. pipe which can direct a stream to any part of the car is used for washing. If the pressure is not strong enough to remove sediment or scale, a hoe fitted with a long flexible handle may be used to good advantage. If there is no bottom outlet, the tank should be filled enough to hold all the sediment in suspension when agitated, so that it may be pumped or siphoned out.

In cases where a workman must enter a tank it should be run full of water to exclude all gases, or a jet of

fresh air run in for a sufficient length of time. A workman entering a tank must be supplied with an approved type of respirator and protective clothing, and if the entrance is through a manhole, he must wear a belt with slings under the arms attached to a flexible cable held at the other end by a man on the outside of the tank. A jet of fresh air from a compressor or some reliable source should be run into the tank as long as there is a man inside.

If an open light or flame is used inside of the tank, we use a helmet which has a hose supplying air from outside the tank or one with a compressed air tank fitted to the helmet, which supply will last for half an hour. Proper supervision is absolutely necessary.

UNDERGROUND PIPE LINES

The same classification, overhead and underground, may be applied to pipe lines. Condition of climate enters as a factor, so that underground lines are preferable in colder climates when not housed or in heated buildings. For outside use where a number of lines are run parallel they should be set below the frost line in half round tile and cover, these acting as a conduit, with a break at intervals to serve as a drain in case of a leak or break. The tile cover not only prevents seepage but can easily be removed for making new installations or repairs.

Pipes, when set in this manner and given a coat of resisting paint, will last for a long while without showing any signs of external corrosion. An exhaust steam line may be run through the conduit to maintain an even temperature in winter months. For heavy pipe or pipe of large diameter such installation is costly and unnecessary.

With underground lines a burst can do little or no damage, there are no drips to contend with, all valves can be reached from above, the tripping hazard is eliminated, no installation is required, there is no freezing in the lines and no danger from falling material when the installation is made.

All valves, cutoffs, cocks, etc., must be clearly marked and open ends tagged to show what is being handled in the line. When compression is used to force the liquid through the lines, all connections should be flanged and the line tested before being put into use.

OVERHEAD PIPE LINES

Overhead lines present quite a few hazards. In routing the lines care must be taken to see that those to contain toluene, benzene, alcohol, etc., are not run above or too near to open flames, boilers and switches, as a drip may become ignited.

Where it is required that acid, lye or other such lines cross passageways, they should be jacketed to prevent a drip or spray from falling on anyone beneath. The hangers supporting pipe should be strong enough to support the weight of a man in addition to the working load, as invariably you will find some person who will lean a ladder against, or stand on a pipe.

All overhead lines should be marked in some way to indicate their contents. The most desirable method is that of painting the lines of different colors, but where this cannot be carried out, all cocks, valves and lines should be marked in some way, and at open ends warning signs should be placed, stating what precaution should be taken or protection worn when handling the contents.

Difficulty sometimes arises due to an accumulation of sludge or the tendency of a liquid to crystallize in the pipe. The latter can in most cases be prevented by using a small steam coil about the pipe and covering with asbestos. Overlooking such a precaution was the cause of an accident at our plant. A length of 1½-in. steel pipe was carrying hot material which crystallized near the open end. In thawing out the pipe, the man used a blow torch, starting at the open end to allow the material to run out as it thawed, which it partly did. Some of it recrystallized, closing the pipe and building up pressure where the torch was being applied. This caused the pipe to blow out along the seam, driving the hot material with such force that it penetrated the man's clothing, burning his arms and chest.

STEADY CREW SHOULD HANDLE INSPECTION AND REPAIR WORK

A periodical inspection should be made of all lines and any faulty valves, leaking connections or corroded pipe be replaced and all lines no longer in use removed. Discarded lines should be allowed to drain, or, better still, be washed out, forcing water or air through them. Too often temporary lines are allowed to remain after having served their purpose. Work on lines should be done from a scaffold built on a level with the line, by persons wearing the proper safe clothing and goggles. Where a connection is to be broken, it should be covered with a shield or covered with a reasonable amount of sacking or rags to absorb drips and a warning sign should be hung below. In all cases the pipe should be supported so that it can be lowered to the ground and not left to fall.

It is very important to have a steady crew to do this work, men who know the rules and observe them, because it is through errors on their part that they or others are injured.

An Application of Super-Centrifugal Force

BY EUGENE E. AYRES, JR.

THREE years ago the commercial centrifuge was unknown to the refiner of vegetable oils. Today the centrifuge is recovering about 225,000 lb. per day of edible oils. Each pound of edible oil recovered means the loss of only about one-half a pound of crude soap material. Each pound of oil recovered means from 6c. to 10c. net profit. For 1920 the collective profit to the refiners in the United States will amount to about \$4,000,000.

The profitable quality of a technical process is not always a correct index of its value as an element of scientific progress, but this case is interesting in that an old familiar principle only modernly understood has accomplished what every refiner has wished to accomplish since the first kettle of cottonseed oil was agitated with lye.

This description is intended not for the vegetable oil specialist, who is already familiar with the process, but for the industrial chemist who may be confronted with similar problems.

An economist would express the refining problem as follows:

The oil expressed from cotton seed is crude oil, in the sense that it is unfit for food products or for the manu-

facture of fine soaps. Crude cottonseed oil is evaluated not on the basis of its value as crude but on the basis of the yield and quality of refined oil that may be obtained from the crude by acceptable refining methods. As for quality, the refined oil must have pleasant taste and odor or the absence of taste and odor, and a properly pale yellow color.

The refining is in three steps—a caustic soda treatment to remove fatty acids and allied impurities, bleaching with fullers earth, and deodorization with steam, losses from these operations being in the order given. Losses from the caustic soda treatment are appreciable always and sometimes incredibly high. Research has not disclosed a suitable substitute for the caustic soda treatment. Other alkalis or the use of chemical substances (with few exceptions) in conjunction with caustic soda will produce oils that may not be properly deodorized and bleached.

SOAPSTOCK

The refiner's chief problem has been to secure a higher yield of refined oil without impairing the quality.

The byproduct from the refining is a mixture of soap, oil and impurities. This is called soapstock. The soapstock has a market value as a base for soap manufacture, but the value of soapstock (on the basis of fatty acid content) is from 6c. to 10c. less than the value of refined oil. The obvious thing to do is to conduct the refining in such a manner as to leave as little oil as possible in the byproduct soapstock. Failing this, the oil in the soapstock should be recovered as such.

OIL IN SOAPSTOCK

The practical refiner would narrow the problem as follows:

Suppose a crude oil is composed of 97.5 per cent neutral oil and 2.5 per cent of free fatty acid and associated impurities. To remove the free fatty acid and impurities it is necessary to use an excess of caustic soda. The amount of excess reagent is the minimum that will yield a proper quality of refined oil. After separating the crude soap thus formed, from 100 lb. of crude oil 92.5 lb. of neutral refined oil will be normally recovered. Five pounds of oil that was present in the crude has been lost.

The loss may be fairly distributed between actual saponification by the excess alkali and mechanical association with the byproduct soapstock. The saponified oil cannot, of course, be reclaimed, though refining modifications have been suggested by which the extent of saponification of neutral oil may be reduced. But the oil in the soapstock (about 2.5 lb. in this case) should yield to some recovery procedure.

NATURE OF MECHANICAL LOSS

From a chemist's viewpoint, the mechanical loss of oil occurs in the following manner:

When a volume of rancid oil is agitated with a smaller volume of caustic soda solution, a complex emulsion is produced. In this emulsion, oil is continuous. The suspended globules are not globules of soap water, but are globules of a secondary emulsion. This secondary emulsion is composed of continuous soap-water with very small globules of oil suspended. The oil in the refining kettle immediately after the addition of lye is, therefore, present in two phases—a primary continuous phase and a secondary dispersed phase.

After the break occurs the globules of the secondary

emulsion coalesce and sink, to form a compact layer. This is soapstock. The refined oil that is pumped out of the kettle is the oil that composed the primary continuous phase of the refining emulsion. The oil that was dispersed as globules in the secondary emulsion cannot be pumped out as free oil, for it is stubbornly enmeshed in the soapstock. This oil is enmeshed rather than suspended, because coincident with the "break" is a gelatinization of the strong soap-water, and as the jellied globules coalesce and sink, the tiny dispersed globules of oil are deformed and lie in irregular streaks and strata in the soapstock. The viscosity of the gel is too great to allow interfacial surface tension to act.

The principal emulsion problem of the cottonseed oil technologist has been naturally with reference to the refining emulsion—to insure a proper agglomeration and settling of the soapstock, and to secure conditions that will leave a minimum percentage of the oil as a secondary dispersed phase. Investigation of this point is difficult, because modifications in refining technique involve so many limiting factors, such as, for instance, color and taste.

The recovery of oil from soapstock, on the other hand, is not greatly complicated by questions of oil quality, for the reasons that the recovered oil can be so readily re-refined with caustic soda and the quantity of recovered oil is small compared with the output of the refinery. Such a recovery is a problem in subsidence.

Physically, soapstock is rather a nondescript mass of soap, water, oil, solids, salts and organic impurities. Although a little free oil will usually settle out of hot soapstock, it is not possible to separate even a trace of free oil when a hot soapstock is pumped through a most powerful centrifuge. This is easily accounted for by the fact that the recoverable oil is in an extremely unstable condition. The gelatinization of the soap solution while deforming the oil globules also causes considerable agglomeration of oil into strata, but if the viscous mixture is thoroughly agitated, the oil is again dispersed. With such an unstable condition, recovery is possible only when the mass can be undisturbed.

When soapstock is diluted with water to the point where it is no longer gelatinous it may be described as follows:

The continuous phase is water with a trace of inorganic matter dissolved and certain organic matters in colloidal dispersion.

Under a microscope of highest power, the continuous water phase of the soapstock is usually transparent, with a yellow color. In bulk the aqueous phase, when completely freed from oil (by filtration, for instance) is dark brown in color, but transparent, without the faintest trace of opalescence. Under the microscope the oil globules are without color and vary in size from 0.02 mm. down to 0.002 mm., or even smaller. When not prevented by viscosity, the smaller particles exhibit decided Brownian movement.

USE OF CENTRIFUGAL FORCE

Centrifugal machines may be divided into two classes: (1) Those which induce filtration, such as the hydro-extractor; (2) those which induce subsidence. The latter type is applicable to emulsions.

Centrifugal force (like gravity) has two functions—to move the globules down or up, depending upon relative specific gravities, and to cause adjacent globules to coalesce. Centrifugal force has been successfully utilized in the past for the separation of emulsions that

yield both to subsidence and to coalescence. With one exception, emulsions whose globules will not coalesce under centrifugal force have never been resolved centrifugally on a commercial scale. The one exception is milk, oldest and best-known example of centrifugal separation. The cream separator, however, has always been a product of purely empirical design. The more modern centrifugals, adapted, for example, to the separation of water from petroleum, are designed with full scientific understanding of the emulsions for which they are intended.

The cream separator is a practical success only for milk. The subsidence-coalescence centrifugals are not successful with emulsions wherein coalescence will not take place. It has been necessary, therefore, to determine the fundamentals of the class of emulsions of which milk is a special case. This difficulty offers the best explanation of the fact that dilute soapstock emulsions were not satisfactorily centrifuged until recently.

CENTRIFUGAL PROCEDURE IN OIL REFINERIES

The soapstock must be diluted until it is no longer gelatinous. The thin emulsion is subjected to centrifugal force for a sufficient period to move to the surface all oil globules that do not exhibit Brownian movement. The emulsion is thus divided into two new emulsions, one saturated with oil, the other containing only the smallest globules. It is customary to refer to the one as the "light" emulsion, while the other has so few emulsion characteristics that it is termed the "heavy effluent."

The light emulsion on microscopical examination is found to possess a structure similar to that of the diluted soapstock, except that (1) the oil globules are nearly uniform in size, averaging 0.008 mm. in diameter, and (2) the oil globules are packed together very closely, touching each other in all directions.

The heavy effluent from cottonseed oil soapstock consists microscopically of a clear yellow phase containing a few scattered spherical oil globules averaging 0.002 mm. in diameter.

To obtain continuous oil from the light emulsion it is convenient to add salt water and recentrifuge. The salt wholly or partly precipitates the soap from solution and in this way tends to reverse the form of the emulsion—to make oil continuous and water globularly suspended. Emulsions of this type are easily separated by centrifugal force. Preparatory to recentrifuging, other chemical methods of breaking down emulsion stability are satisfactory, but salt is economical and efficient.

Under correct operating conditions, the centrifugal process appears to recover about 60 per cent of the neutral oil present in the soapstock. Yields have been reported as high as 78 per cent and as low as 40 per cent.

It is not to be supposed that any plant now in operation is operating at maximum efficiency. The soapstocks produced at the various refineries are different in many respects. For example, in one refinery it was found that the centrifugal recovery yields were very low because of the fact that the water used for the dilution of the soapstock had been softened. Soft water is not as good as hard water when emulsion stability is to be reduced. Maximum efficiency will come, of course, only as the conditions at each recovery plant are more and more thoroughly understood, and when suitable operating modifications are adopted.

Philadelphia, Pa.

The Separation of Mineral Matter From Natural Flake Graphite

BY W. C. RATLIFF AND JOSEPH D. DAVIS

AMERICAN flake graphites, as they are put on the market, contain rather large percentages of ash. The ash content of Alabama graphite, for sample, ranges from 9 to 15 per cent, and the figures for Pennsylvania graphite are about the same. The dust or fines resulting from the refining or grading of the flake are much higher in ash. No. 1 dust from Alabama flake¹ graphite contains about 55 per cent ash, while the ash content of No. 2 dust will run as high as 70 per cent.

The Bureau of Mines has been conducting investigations looking toward the better utilization of American graphites, and this paper represents a part of the investigation.

There may be some question as to the economy of further purification of the coarser flakes, particularly when they are intended for use in crucible making, but the dusts as they come from the refinery are not readily marketable, and it is believed that if they were free from mineral matter they would be in demand for such purposes as the manufacture of stove polishes, graphite paints and lubricants, and particularly for the manufacture of graphite electrodes. It was for the purpose of developing a method for the purification of dusts that the experimental work which follows was undertaken.

METHOD ADOPTED FOR PURIFICATION

The method used in this experimental work was that devised by Lieutenant Walter E. Trent primarily for the purpose of removing mineral matter from coal. The method is essentially as follows:

The coal to be treated is finely pulverized and thoroughly wetted with water, the weight of water added being at least twice the weight of the coal. Enough oil is then added to saturate the coal (usually about 1 part oil to 2 parts coal), and the mixture is thoroughly agitated with some efficient type of mechanical agitator. The effect of the agitation is to cause the coal and oil to be agglomerate, leaving the mineral matter suspended in the water, with which it can be poured off from the coal-oil mixture. By repeatedly agitating the coal-oil mixture with fresh portions of water and pouring off the wash water, a large part of the extraneous mineral matter can be removed. Most of the water held mechanically by the pasty mass of oil and coal can now be removed by squeezing as butter is worked.

PRELIMINARY EXPERIMENTAL WORK

A 100-g. sample of Alabama flake graphite was thoroughly agitated in a small hand churn with 100 c.c. of topped crude oil of paraffine base and 0.87 specific gravity, and about 200 c.c. of water. The graphite and oil agglomerated with a fairly good separation of the water. The water, however, carried only a small amount of mineral matter from the graphite, and the sample was known to contain over 12 per cent ash.

It was now decided to investigate the effect of fineness of grinding. Accordingly, a fairly large sample of the Alabama flake graphite was ground in water for about eight hours in a ball mill, and then filtered

and dried for one hour at 105 deg. C., to remove all the moisture. On visual inspection, the size of the flakes seemed to have been considerably reduced. On close examination, however, under the microscope, Dr. Reinhardt Thiessen of this bureau found that the area of the flakes had not been greatly reduced, but that they had been reduced in thickness. The thin laminæ of which the flakes are made up had been separated, leaving the mineral matter held between the laminæ exposed. A 60-g. sample of this ground graphite was agitated with 60 c.c. of topped crude oil and 120 c.c. of water. The water decanted from the agglomerated mass of graphite and oil carried with it quite a large amount of mineral matter resembling clay. Fresh water was added and the mixture was again thoroughly agitated, after which the water was poured off from the graphite and oil, containing apparently as much sediment as that from the first treatment.

The washing with water was repeated until the water came off clear, six washings being required in all. All the washings were then collected and filtered, and the residue was ignited in a muffle furnace for one hour, after which it was cooled and weighed. The weight of the residue so obtained amounted to 10.16 per cent of the weight of the sample treated. A portion of the graphite-oil mixture was now extracted with benzene to remove the oil, the benzene was driven off and the amount of ash in the residue was determined. It was found to contain 3 per cent ash, whereas the original graphite sample contained 13 per cent ash.

Another test was made wherein only half as much oil was used as in the test just described, but this amount of oil failed to effect good agglomeration. About equal portions of oil and graphite gave the best results. The amount of water required was approximately twice that of the graphite. Further additions of water had no effect on the agglomeration, but aided in keeping the mineral matter in suspension so that it could be more readily removed from the oil and graphite.

COMPARATIVE EFFICIENCY OF DIFFERENT AGGLOMERATING LIQUIDS

Having found that heavy oil gave fairly good results as an agglomerant, it was decided to try the agglomerating effects of lighter and more volatile liquids, the idea being to find a liquid that would do the work as well as the oil and at the same time be more readily recovered by volatilization. No doubt the surface tension and viscosity of the liquid used have an important bearing on its behavior, but these are matters which require more extended study than this paper contemplates. The known requirement of a liquid agglomerant is that it must be immiscible with water. Benzene, toluene and carbon tetrachloride answer this requirement and were selected for comparative test with oil. All these liquids gave good agglomeration when churned up with the graphite and water, but the carbon tetrachloride apparently gave the cleanest separation of the water and agglomerated mass. The comparative washing efficiencies of the liquids were now determined quantitatively.

For the determination, large samples (approximately 2 lb.) of Alabama and Pennsylvania graphites were ground in a ball mill with water for about eight hours. The samples were then dried at 105 deg. C. until all the moisture was removed. Fifty-gram samples of the ground graphites were thoroughly agitated with 50-c.c. portions of the different liquids, about 200 c.c. of water being added in each case.

¹Published by permission of the Director of the Bureau of Mines.
²Downs, F. G., "Grading of Graphite in Alabama," *Eng. and Min. J.*, Feb. 9, 1918, pp. 282-283.

The agglomerated residues were now washed until the decanted water was clear. This required from five to eight washings with 200 c.c. portions of water. The benzene, toluene and carbon tetrachloride, being readily volatile, were easily driven out of the graphite by heating, and the oil was extracted from the oil-graphite residue with benzene. After thoroughly drying all the samples, duplicate samples of each were weighed out and ashed to constant weight in a muffle furnace at about 800 deg. C. Table I gives the results of the washing tests.

It will be noted that the efficiencies of benzene, toluene and carbon tetrachloride are very nearly the same, whereas that of oil is different and not so good. In the

TABLE I

Per Cent Ash in Alabama and Pennsylvania Graphites Before and After Treatment With Topped Crude Oil, Benzene, Toluene and Carbon Tetrachloride

Kind of Graphite	Un-treated	Treated With			
		Oil	Benzene	Toluene	Carbon Tetrachloride
Alabama	11.68	4.28	3.44	3.41	3.30
Pennsylvania	10.03	6.43	5.54	5.71	5.55

case of the Alabama graphite the amount of mineral matter removed by the lighter liquids averages 72.7 per cent of the total mineral matter contained, while that removed by the oil is 63.3 per cent of the total. In the case of the Pennsylvania graphite, the light liquids removed 44.1 per cent of the total mineral matter and the oil removed 35.8 per cent of it. The greater efficiency of the treatments in removing ash from the Alabama graphite may be accounted for by the fact that the Alabama flake was finer than that from Pennsylvania. This is shown in Table III, which gives the size tests on all samples used.

Although the efficiencies of benzene, toluene and carbon tetrachloride are about the same, carbon tetrachloride was used in making further tests, since it gave the best agglomeration and the cleaner cut separation of the agglomerate from water.

EFFECT OF SIZE OF GRAPHITE PARTICLES

Fairly large samples (approximately 100 g.) of the Alabama and Pennsylvania graphites were ground in the ball mills for eight hours and then treated with carbon tetrachloride and washed to free them from suspended mineral matter. The samples were then dried at 105 deg. C. to remove all the carbon tetrachloride and moisture. Small samples of the residues were reserved for determination of ash and the remainders were again ground wet in the ball mills, this time for twelve hours. They were then treated with carbon tetrachloride and separated mineral matter was removed by

TABLE II

Per Cent Ash Remaining in Alabama and Pennsylvania Graphites After Eight and Twenty Hours Grinding, and Treatment With Carbon Tetrachloride

Kind of Graphite	Per Cent Ash	
	Ground 8 Hr.	Ground 20 Hr.
Alabama	3.51	1.56
Pennsylvania	5.65	1.75

washing as before. The resulting agglomerates were now dried and ash determinations were made on the dried final product. The results of the tests, as shown by the ash determinations, are given in Table II.

In order to get the relation between the fineness of the graphites and the amount of ash removed in each case, size tests were made on all samples treated, and the results of the tests are given in Table III.

TABLE III
Results of Size Tests on Alabama and Pennsylvania Graphites

	Alabama Graphite			Pennsylvania Graphite		
	Un-ground	Ground 8 Hr.	Ground 20 Hr.	Un-ground	Ground 8 Hr.	Ground 20 Hr.
On 48 mesh	11.7	9.5	1.5	74.4	80.6	10.3
Through 48, on 100 mesh	82.2	70.0	32.9	25.0	15.4	32.7
Through 100, on 200 mesh	5.2	12.7	31.1	0.1	1.7	28.2
Through 200 mesh	0.9	7.8	43.5	0.5	2.3	28.8

These size tests give only an approximation of the actual sizes of the graphite flakes, since in every case the flakes were somewhat broken up in going through the screens. Particles that should have been retained on the screens passed through before constant weight on the amount retained could be secured. This is true of the unground sample of Pennsylvania graphite, where a smaller quantity was retained on the 48-mesh screen than that retained on the same screen after eight hours' grinding. However, in general, the size tests do show a reduction in size by grinding. Microscopic examination showed that the thickness of the flakes had been greatly reduced, but that the area had not been reduced so much. By picking apart the flakes with a needle, particles of clay could be dislodged from the laminae. The main effect, then, of grinding the flake graphite was to break apart the laminae and expose the mineral matter, which was then easily removed by treatment with carbon tetrachloride with subsequent washing.

TREATMENT OF OTHER GRAPHITE SAMPLES

A sample of Alabama flake dust, containing 37.63 per cent ash and of such fineness that 52 per cent of it passed 200 mesh and the remainder passed 100 mesh, was treated with carbon tetrachloride and washed in the usual manner. After treatment, the ash remaining in the graphite amounted to 22.59 per cent. This residue was now ground wet in a ball mill for seven hours, and, after washing, the amount of ash still held by the graphite was 7.87 per cent.

A very finely pulverized sample (100 per cent passed 200 mesh) of amorphous Mexican graphite was treated with carbon tetrachloride and washed free from separated mineral matter in the usual manner. The ash content of the original sample was 15 per cent and the amount remaining after washing was 7.5 per cent. It was shown that the ash content of the sample could be further reduced by grinding, but quantitative reduction tests were not made.

CONCLUSION

From the results of the experimental work just described, the following conclusions may be drawn:

1. Graphite, both flake and amorphous, may be cleaned by agitating with oil and water.
2. Light volatile liquids, benzene, toluene and carbon tetrachloride, are better adapted to the cleaning of graphite than oil. It is probable that this is due mainly to their lower viscosity. It was noted that with the lighter liquids the agglomerates formed were much less viscous and that mineral matter separated with much less agitation than in the cases where heavy oil was used.
3. The extent of the cleaning effected by this method depends indirectly on the fineness of the graphite treated. The value of grinding is not so much due to actual size reduction thereby as to a separation of the mineral matter from inclosing carbon.

Molybdenum During 1917-1919*

BY FRANK L. HESS

THE molybdenite deposits of the United States are legion. This mineral has probably been found, at least in small quantity, in every state in which there are any considerable outcrops of granite. In the Rocky Mountain and other Western States individual occurrences are too numerous to record. Like gold leaf, molybdenite is apt to be spread so thinly and to make so great a show compared with its real bulk that a much exaggerated impression of its quantity is had unless dependence is placed on assays alone. Molybdenite [the sulphide of molybdenum (MoS_2) and by far the commonest molybdenum mineral] is so attractive when seen in the white quartz in which it is commonly found and so deceptive in its appearance of quantity, and so many stories of its great usefulness and value have been current, all with a touch of the mystery connected with supposed secret uses, that many persons have been induced to invest much more labor and money in molybdenum mining enterprises than careful investigation would warrant.

In 1918 the United States retained its lead as the greatest producer of molybdenum by an output of 431 short tons of metal in 2,280 tons of ore and concentrates valued at \$1,253,700.

In 1918 the center of production moved from Arizona to Colorado. The dumps of the old Mammoth gold mine, from which a large part of Arizona's production had come, had yielded their crop of wulfenite, though the mine is still productive; but the great size of the Colorado deposits and the large mills give an output which is far greater than that of any other state.

DISPOSITION OF MOLYBDENUM IN 1917

The Atlantic Metal & Alloys Co., Boonton, N. J.; the Arizona Rare Metals Co., Tucson, Ariz.; the Primos Chemical Co., Primos, Pa.; and the Rose Chemical Co., Los Angeles, Cal., made ferromolybdenum during 1917. The Atlantic Metal & Alloys Co. went out of business during that year, and the Tungsten Products Co., of Boulder, Col., took over its slag on hand and produced ferromolybdenum from it.

So far as is known, except for a small quantity used experimentally and another small quantity used by one firm in tool steels, all the ferromolybdenum made in 1917 was exported, most, if not all, going to France, and most of the concentrates produced in this country that were not reduced to ferromolybdenum were also exported to France. Small quantities were used for the production of molybdic oxide, molybdic acid and ammonium molybdate. The molybdic oxide and molybdic acid were used either to make ammonium molybdate or molybdenum (metal).

CONSUMPTION IN 1918

In 1917 and in the earlier part of 1918 there was a good foreign demand for molybdenum ores and ferromolybdenum, and considerable quantities were used by the Ford Motor Co. and the Carbon Steel Co. in the United States, but the domestic market was very restricted and was supplied during the first part of the year mostly by the Climax Molybdenum Co. and the Primos Chemical Co.

The Ford Motor Co. had a contract to supply crank

shafts and connecting rods for Liberty aircraft engines to the Government, and in these 0.35 to 0.50 per cent of molybdenum was used, with more chromium and nickel. A crank-shaft forging weighed 196 lb. and an extra shaft was shipped with every twenty-five Liberty engines. The yield of forging bars was about 60 per cent per heat in the electric furnace, and about 90 per cent of good shafts were obtained from the bars. The connecting-rod forgings weighed about 62 lb. per engine, and each electric furnace heat also gave about 60 per cent of good forging bars but only about 80 per cent of finished forgings from the bars. About 100 crank shafts was the maximum daily output, with presumably an equal number of connecting rods.

During the summer small plates of similar steel exhibited had shown great resistance to light projectiles, and it was proposed to make all armor for tanks and airplanes of similar steel.

The Government did not itself buy any molybdenum ores for the work, but gave its assistance to the companies which were to make the steel in their efforts to obtain ferromolybdenum quickly and guaranteed their contracts. Before the steel was made the company that had advised the use of molybdenum steel announced that it had obtained better results with steel carrying a very small percentage of zirconium, and the company was told to go ahead with zirconium steel if that would afford the best possible protection. Baddeleyite (zirconium oxide) was therefore ordered from Brazil, but before either steel was actually used the armistice was signed and all contracts were nullified.

MARKET CONDITIONS IN 1919

The reaction in the molybdenum market caused by the cessation of hostilities and the withdrawal of the European demand for molybdenum ores and ferromolybdenum probably reached a maximum during the year 1919.¹ The development of new properties and the production of increased quantities of ore, stimulated by the active demand, more especially during 1917, naturally resulted in overproduction as soon as the war demand ceased. The largest single consumer, the Ministry of Munitions in London, announced early in the year that accumulated stocks in the United Kingdom were large enough to meet all demands for at least eighteen months. Most of the production within the British Empire was under contract at a fixed rate. Arrangements were therefore made to reduce drastically all shipments from outlying points to allow existing stocks to be realized and to permit the world's market to settle down to a normal working condition as soon as possible. The Ministry of Munitions therefore terminated the existing purchasing arrangements and no deliveries of molybdenite loaded on ocean steamers from British overseas ports after April 30, 1919, were to be accepted. The Ministry of Munitions also recommended that empire producers, in their own interests, should take immediate steps to reduce the production of these ores.

The agents of the Federal Government of Australia continued purchasing supplies of tungsten and molybdenum ores at the scheduled prices to Dec. 31, under the contracts previously made by the Commonwealth Government with the Imperial Government. During the negotiations the Imperial Government advised the

¹The three following paragraphs are by Alfred W. G. Wilson, Department of Mines, Ottawa, Canada, in "The Mineral Industry During 1919."

*Advance sheets, Mineral Resources of the U. S., 1917, 1918.

WORLD'S OUTPUT OF MOLYBDENUM CONCENTRATES IN TERMS OF THE CONTAINED MOLYBDENUM

(M = molybdenite; W = wulfenite.)

Country	Ore Mineral	1915		1916		1917		1918	
		Quantity (Metric Tons)	Value	Quantity (Metric Tons)	Value	Quantity (Metric Tons)	Value	Quantity (Metric Tons)	Value
Australia.....	M	71.9	\$377,700	70.39	\$314,800	102.05	\$456,273	111.8	\$500,000
Austria.....	W	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Bolivia.....	M	6.5	5,475	5.17	7,663	(a)	(a)	(a)	(a)
Canada.....	M	.....	.....	42.5	156,461	78.5	288,705	102.8	434,528
Chile.....	M	.....	.....	0.8	.....	20.1	9,836	.....	.....
China.....	M	(a)	(a)	0.3	1,409	1.6	1,700	1.08	3,689
Chosen.....	M	.....	.....	3.2	12,463	59.2	19,034	10.7	25,884
Germany.....	M	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
India.....	M	.....	.....	0.4	983	0.7	3,050	0.09	551
Italy.....	M	.....	.....	.....	.....	0.2	(a)	.....	.....
Japan.....	M	.....	.....	18.3	31,177	12.06	30,124	b 70.3	12,746
Norway.....	M	72.3	(a)	73.1	(a)	82.1	533,333	84.9	1,248,804
Peru.....	M	1.3	6,990	3.08	14,120	3.8	20,970	1.3	7,445
Spain.....	W	1.8	1,861	.....	.....	.....	.....	.....	.....
United States.....	{ M W }	82.4	114,866	93.8	205,000	158.8	495,350	390.8	1,253,700

(a) Figures not available. (b) 66.3 tons coarse ore of low grade.

Commonwealth Government that the estimated stock of tungsten and molybdenum minerals in Great Britain at the end of 1919 would be sufficient to meet the requirements of the home and export trade of the United Kingdom for at least two years. It was expected that these stocks would have to be realized by the Imperial Government at prices below the fixed standard at which they had been purchased.

Overproduction, beyond the ability of the market to absorb, quickly resulted either in the accumulation of stocks at some of the mines or in the cessation of mining. Production had stopped at nearly all the mines early in the year, and some new properties that were ready to produce concentrates found themselves without a market.

COLORADO DEPOSITS

The greatest single feature of 1918 in the mining of molybdenum was the building of expensive and elaborate mills by the Climax Molybdenum Co. and the Molybdenum Products Corporation and the development of their holdings on the great deposit on the west side of Bartlett Mountain, at Climax, Summit County, fifteen miles north of Leadville, Col. The Climax Molybdenum Co. had its mill sufficiently finished to carry on experimental work in the latter part of February and in March. In April the mill was running regularly.*

The Molybdenum Products Corporation has a patented claim 150 by 1,500 ft. located on the same ore body, and had the ore on at least three sides of its claim. It got to work later than the Climax Molybdenum Co. and was not so fortunate in disposing of its product, so that it operated only a short time. So far as it is already explored the deposit can probably supply 100,000 tons of elemental molybdenum. Both companies are ready for operation at any time that a demand sufficient to warrant operation arises.

WORLD'S PRODUCTION

The United States and Canada apparently have the largest known molybdenum supplies. It is believed that the United States has the greatest individual deposits and the greatest quantity of available ore, but neither Canadian nor American Government geologists have examined deposits in both countries, and private opinions differ. The United States has for some years been the largest producer of molybdenum ore and is in a position to increase production greatly whenever the market warrants.

The accompanying table shows the world's production of molybdenum contained in ore, so far as the data are

at hand, for the years 1914 to 1918, inclusive. No facts are now known that indicate a greatly different distribution in the near future. It is known that some molybdenite has been produced in Germany and some wulfenite in Austria, but the quantities are unknown.

Legal Notes

BY WELLINGTON GUSTIN

Hair-Line Cracks on Ingot Steel Not Breach of Warranty Against Serious Surface Defects

In the case of the Clark Equipment Co. against the John A. Crowley Co., judgment for the former being recently affirmed in the United States Circuit Court of Appeals, the controversy involved hair-line cracks on the surface of steel ingots, rendering them unfit for gun forgings.

The Crowley company sought to defeat payment for the ingots, claiming the plaintiff had breached its warranty in forging the ingots. The warranty insisted on is found in the order for manufacture given by the Clark company to the Crowley company and in a nearly contemporaneous letter explaining what was wanted. The order was prepared by the buyer and tells the forge company that its acceptance "constitutes a guaranty that all steel furnished [under the order] will be free from all physical defects." The letter charges the forge company that its "responsibility consists" in furnishing steel "free from surface defects and an unusual amount of pipe"; wherefore [wrote the buyer] "please use care; . . . serious surface defects will be cause for rejection of the entire ingot."

Now it was laid down that where the warranty on a sale of goods was contained in the order and letter, both of which were prepared by the buyer, any doubt as to construction of these writings will be resolved against the buyer. The above warranty is one as to quality; the rule applicable being that there must be a substantial compliance, and substantial failure being a breach.

The forge company or seller admitted the existence of "hair-line" cracks on the ingot surface, but averred that it had "chipped out" the same so that the ingot was either "perfect" on delivery, or was made so thereafter, at its expense. There was evidence that such cracks were a necessary result of cooling of metal, and

*See CHEM. & MET. ENG., vol. 19, p. 654, Nov. 1, 1918.

their removal produced perfection, and also that steel of the composition and ingot size contracted for could not resist without cracking the method of forging adopted by the purchaser. On the other hand, the purchaser gave evidence that "fine cracks" discoverable by "a more or less careful scrutiny" existed before forging, and under "the hammering process . . . they became larger."

The only point properly before the court was whether what the seller called "hair-line cracks," removed by chipping, constituted "serious surface defects." It was held that hair-line cracks chipped out before delivery and serious surface defects are not convertible terms, and the jury having found as a fact that the ingots delivered did conform to the terms of the contract, the judgment for the seller was affirmed.

Plant Must Be Operated Not to Interfere With Health of Neighboring Residents

The rules governing liability for maintaining an industrial plant as a nuisance are laid down in the decision of the Supreme Court of Minnesota in two actions brought by Alice Millett against the Minnesota Crushed Stone Co.

Millett brought suit to recover damages extending over a period of six years from the operation of a quarry, crushing plant and grinding mill near her home. It was claimed that because of noise and jar of blasting, the noise and danger of falling rocks, the noise of steam drills and of a steam shovel, and because of smoke and dust, the plant was a nuisance. On trial the jury found against the company and it appealed.

The Supreme Court stated the rules in effect to be that a land owner who has a deposit of limestone or other product on his land may not quarry as he chooses, but he may be liable for maintaining a nuisance in the operation of a quarry and other incidental industries, even though the odors, noise, dust and the like complained of are ordinary incidents of such a business conducted without negligence; that the rights of inhabitants are superior to the rights of trade, and that, whenever they conflict, the rights of trade must yield, that such a business must be conducted in such a manner as not to offend or interfere materially with the health or ordinary physical comfort of people living in the neighborhood.

Two questions were presented for determination by the Supreme Court: First, whether the home owner was entitled to recover for the diminution of the value of the use of the property. Second, whether recovery for personal discomfort, inconvenience and ill health is an additional element of damage.

Answering the first proposition it was said that a property owner whose property is injured by a nuisance may recover for the property damage sustained. This is generally the diminished rental value, if the property be rented, or the diminished value of the use, if the property be used by the owner (2 Sup. Court, 719). This element of damage is recoverable only by the owner (Jefferson Fertilizer Co. vs. Rich, 62 So., 40).

Answering the second proposition, the court said the rule was now well settled that in an action for damages for maintaining a nuisance recovery may be had for inconvenience, physical discomfort and illness to the occupant of the property resulting from the nuisance. This element of damage is something additional to the element of diminished rental value.

In an action for a private nuisance, affecting injuriously the health and comfort of the occupants of the homestead, the husband and father of the family, if he be the owner, may recover for any discomfort, annoyance or illness suffered by himself or any member of his family resulting from the nuisance. And it is not permitted to each member of the family to maintain separate actions to recover these elements of injury. This rule is laid down to avoid a multiplicity of law suits.

Company Has Right to Replace Old System to Preserve Investments

An attempt to enlarge profits in salt manufacture got the Buckley & Douglas Lumber Co. into the courts through a controversy among its directors. In an earlier case brought by the State of Michigan against it, the company was permitted to manufacture salt as an incident to the manufacture of lumber, and as the salt business was extended of late years, the quantity of logs sawed has diminished.

The increasing manufacture of salt brought about an increasing problem of fuel. Coal burned by the company in plant 1 amounted in 1915 to \$45,435; in 1917, \$86,468; and in 1918, \$153,575. The value of the salt block and equipment in 1910 was about \$225,000, and in 1918 about \$350,000.

In 1918 a contract was entered into with the Manistee Iron Works Co. for the installation in plant 1 of new pans and a new system of applying steam thereto whereby it was claimed the same quantity of salt could be produced by the use of one-fourth the amount of fuel. The purchase price of the new equipment was \$238,650, and the cost of installation would make the total cost thereof about \$300,000.

The complaining directors, who voted against this transaction, brought suit against the companies and majority directors, contending the contract was unlawful, and asked that the court declare said contract *ultra vires* and void, and that defendants be restrained from doing any act under it, holding the individual defendants personally liable.

The questions presented were: First, had the board of directors the power to enter into the contract to replace with the iron company? Second, if they had such power, was the making of such contract a legal fraud upon the rights of the minority stockholders?

The court said the board had the same right as a copartnership or an individual would have to enter into any contract reasonably adapted to further the business of the corporation, if within the powers conferred by its charter. They may generally do whatever an individual, acting intelligently and honestly, would do under similar circumstances.

Plant 1 included a warehouse with a capacity of from 350,000 to 400,000 bbl., five salt wells about 2,000 ft. deep, railroad tracks, docks and shipping facilities, besides apparatus for manufacture of salt. Its total cost has been about \$350,000. The board was found to be justified in preserving this investment in the manner it followed, by replacing worn-out salt-manufacturing apparatus with a new system which allows greater salt production with less fuel. And the directors had the power to contract in good faith to replace worn-out apparatus for its incidental salt manufacturing, and such was not a fraud on minority stockholders. Such was the judgment of the Supreme Court of Michigan.

Notes on Pulp and Paper*

THERE are four general processes of reducing wood to a pulp condition—namely, the ground wood, sulphite, sulphate and soda processes of pulping.

THE GROUND WOOD PROCESS

The ground wood process of pulping is used mainly for the reduction of non-resinous, long-fibered wood, such as spruce and balsam. The barked wood in 2-ft. lengths is ground on a grindstone, the surface of which has been sharpened to produce a cutting action. The yield of pulp is approximately 90 per cent of the weight of the raw wood. The pulp is inferior in quality and is used only to mix with longer- and stronger-fibered stock—such as unbleached sulphite pulp—in the manufacture of paper in which permanency is not required, as in news-print, cheap catalog, magazine and certain other papers. It is also used to a large extent in the manufacture of wall board.

THE SULPHITE PROCESS

The sulphite process is used chiefly for the reduction of long-fibered, non-resinous, coniferous woods, such as spruce, balsam and hemlock, giving a yield of less than 45 per cent based on the weight of the original wood used. This pulp can be bleached to a high degree of white and is largely used both unbleached and bleached in the manufacture of books, news-print, wrapping, bond and tissue papers.

THE SULPHATE PROCESS

The sulphate or kraft process of pulping is used for the reduction of any long-fibered wood and yields approximately 45 per cent. This is an alkaline process and can be used for the reduction of both resinous and non-resinous woods, such as the pines, spruces, hemlocks, firs, etc. Kraft pulp is normally not bleached but on account of its strength it is used for the manufacture of kraft wrapping paper and high-test container board.

THE SODA PROCESS

The soda process is restricted in use to the short-fibered deciduous woods, such as aspen, cottonwood, willow, gum woods, etc., yielding less than 45 per cent. The resulting pulp is invariably bleached to a high degree of white, and after admixture with a longer- and stronger-fibered stock, such as spruce sulphite, is used for the manufacture of book, lithograph, envelope papers, etc.

COST OF A PULP AND PAPER MILL

No accurate figures are available as to the cost of a pulp and paper mill, but it is the opinion of the laboratory that under present conditions a balanced pulp and paper mill cannot be erected at a cost of less than \$45,000 or \$50,000 per ton capacity of finished paper per day. It is not feasible, except under abnormal conditions, to erect a pulp plant of less than twenty-five tons capacity, requiring approximately sixty cords of wood a day. Before proceeding with the erection of a pulp and paper mill a competent engineer who has specialized in this field should make a very careful survey of the economic conditions, such as labor, markets, living conditions, cost of fuel and power, as such factors are of decided importance

in determining whether or not the enterprise will be a financial success.

American conditions are deemed unsuitable for plant fiber paper. General investigations have shown that fibers such as sugar cane bagasse, corn stalks and various straws offer the following difficulties in handling:

DIFFICULTIES IN USING PLANT FIBERS

1. Plant stalks, straws, grasses, etc., usually contain a large percentage of pith, giving pulps low in fiber content and requiring high chemical consumption.

2. Material of this type represents seasonal crops, so that facilities must be provided for the storage of a large volume of the stalk in order to permit the paper mill to operate throughout the year. The susceptibility of such material to decay adds greatly to the costs and difficulties of storage.

3. Due to the bulkiness of these materials the digester charge is reduced, thereby reducing the yield and increasing overhead costs proportionately.

Some of these fibers, such as straws, are being pulped at the present time for use in the manufacture of corrugated board and cheaper board products. Pulp of this nature, however, does not compare with a refined pulp such as sulphite or rag stock; it can be used only for special purposes and not in the manufacture of news-print or high-grade paper. Plant fibers of this nature are being reduced commercially in Europe where economic conditions and the scarcity of wood permit their utilization.

AVAILABILITY OF SOUTHERN WOODS

There has been considerable inquiry concerning the suitability of Southern woods for paper manufacture. While these have a good fiber length, on account of their pitch content they cannot be reduced by either the sulphite or the ground wood process to compete commercially with pulp made from Northern coniferous woods, such as spruce, balsam or hemlock.

SOUTHERN PINES

The various species of Southern pines can best be reduced by the sulphate, or kraft, process of pulping, and the resulting pulp utilized for the manufacture of kraft wrapping paper or high-test container board. These pines can also be reduced by the soda process and the resulting pulp utilized in the manufacture of grades of paper in which sulphate pulp is ordinarily used. It is possible that further work will demonstrate the feasibility of pulping these pines by the sulphate process, bleaching the pulp to a satisfactory degree of white and mixing it with short-fibered sulphate or soda pulp made from other Southern woods, such as the gum woods, for the production of magazine, book, envelope or lithograph papers. The yield of pulp by the soda and sulphate processes is less than 45 per cent.

SOUTHERN HARDWOODS

The large stands of hardwoods occurring in the South consist in part of the various species of gum wood, cottonwood, sycamore, basswood, magnolia, willow, etc. All of these woods are short-fibered and, according to laboratory experience, can be most satisfactorily reduced by the soda and sulphate processes of pulping. This pulp after admixture with a longer- and stronger-fibered stock, such as bleached spruce sulphite or pine sulphate pulp, can be used for the production of book, envelope or lithograph paper.

*Abstracts from the Forest Products Laboratory Technical Notes.

Producer Gas-Fired Boiler Installation in France

A Description of the Installation and Operation of a Producer Gas-Fired Boiler Plant at the Montrambert, Loire, Coal Mines, Using Coked Slack and Mine Waste for the Production of the Gas

By JOHN H. BARTLETT, JR.

ENGINEERS and works' managers are frequently heard to express certain doubts as to the possibility of obtaining complete combustion with gas of very low calorific value without the use of supplementary heat furnished by pre-heating the air destined to support this combustion.

Difficulties in lighting and in maintaining a stable combustion are feared and it is commonly considered to be of prime necessity to provide for an excess of air in order to insure the gas being completely burned. For the most part, these ideas are traceable to the fact that the designs and equipment used have almost always been more or less defective, and it is thought that in this connection a short description of the tests recently made on firing a water tube boiler with lean producer gas at Montrambert (Loire) may be of some interest.

Some readers may be already familiar with the studies and experiments carried on during latter years by the Société des Houillères de Montrambert et de la Béraudière of St. Etienne (France) with the aim of utilizing in the most economical and rational way the slack from its mines and its low-grade coals. In order to pursue these studies this company built a complete test works of 500 kw. capacity which is operating regularly at present, furnishing the power used in the

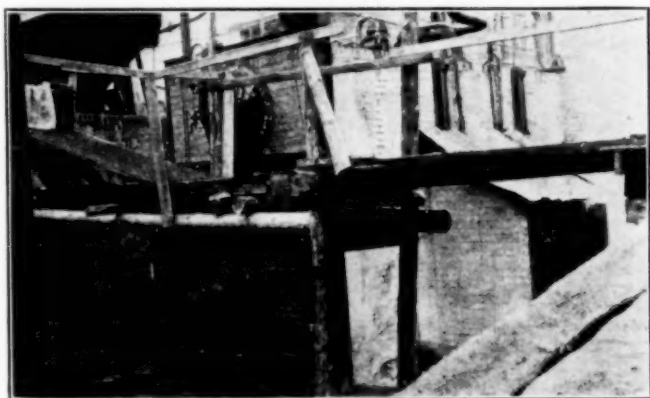


FIG. 1. THE BUTTNER BOILER WITH GAS BURNER INSTALLED

exploitation of the shafts at Montrambert and producing a surplus which is turned on to the distribution system of the Cie. Electrique de la Loire et du Centre, with which this installation is connected. A few words will perhaps be necessary to describe hastily this installation and to explain the connection between these projects and the tests recently made upon the use of producer gas for boiler firing.

In order to utilize this slack and mine waste, which is a coking fuel containing 42 to 45 per cent of moderately fusible ash and 18 to 20 per cent of volatile matter, the Société des Mines de Montrambert has had recourse to gasification, dividing the operation into two

parts. The coal is first charged into coke ovens, the byproducts being recuperated and the waste heat employed for steam generation; the coke thus formed is next utilized in gas producers and the gas produced is employed in two internal combustion engines for generation of electrical power.

By this method are avoided the difficulties resulting from a direct treatment in producers of a coking coal, rich in viscous tar and which produces continuously, through agglomeration, compact masses of clinker in

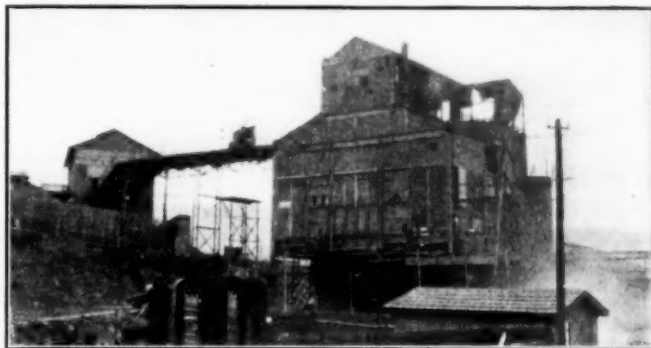


FIG. 2. GENERAL VIEW OF PRODUCER INSTALLATION

the producer and gives off a gas whose purification is extremely difficult. These low grades of coal can be handled very well in coke ovens and the use of coke in the producers permits an exact regulation of the latter, making it possible to produce a gas which is practically constant in composition and calorific value.

Since this gas is to be used in internal combustion engines its purification is necessary; but the Société des Mines de Montrambert considers that even if the gas were destined for industrial furnaces or boilers it would be worth while in most cases to purify it to a certain extent and to recover, as far as possible, the condensable byproducts and the sensible heat carried by it.

Its installation of two 10-ft. rotating grate producers is therefore completed by purifying and cooling apparatus which insures the deposit of the dust and tar contained by the gas, and which cools and so dries it, pre-heating the air blast for the producers at the same time. In this same apparatus the hot air is saturated with water and the proportion between the weights of water vapor and air furnished to the producer is easily controlled by regulating the temperature of the air.

The gas after its passage through this apparatus is discharged by an extractor into a series of purifying cases and finally passes to a holder from which it is drawn by the suction of the gas engines.

A supplementary installation is added to the equipment mentioned above for the recuperation of the nitrogen content in the coke, of which about 70 per cent is

recovered in the form of ammonia salts. The further recovery of sulphur compounds and other products is being studied.

The works has been in normal operation for about two years, furnishing a monthly production of 200,000 kw.-hr. which is utilized by the Société des Mines de Montrambert or discharged upon the system of the local electric company. Its operation has been so successful that the Société de Montrambert is at present considering the construction of a large works comprising coke ovens and producers capable of handling all the low-grade coal and non-salable waste produced by

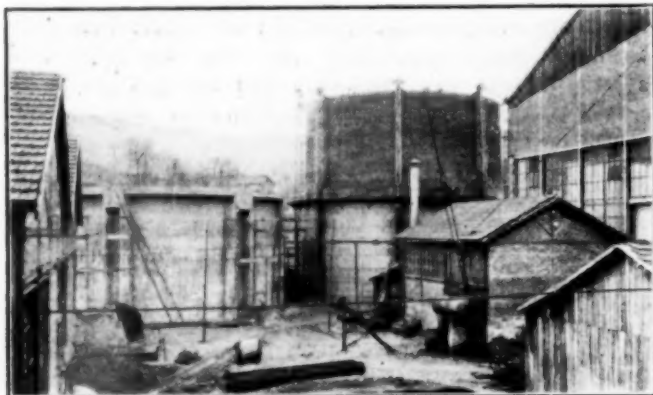


FIG. 3. GAS HOLDER

its various mines. It was as part of this project that this company decided in 1919 to experiment upon the use of the available producer gas for the firing of boilers in order to determine whether this gas was suitable under practical conditions for such an application and also to find out what efficiency could be expected of a boiler so fired and whether it would be advantageous to provide batteries of boilers supplying turbo-generator groups instead of internal combustion motors.

For this test the company chose the boiler installed near the battery of coke ovens and which is normally heated by waste gases from the latter. This boiler (Fig. 1) is of the Büttner type (water tube) having a heating surface of 80 sq.m. (about 860 sq.ft.) and is installed in the open air without economizer or feed water heater. It had been in operation for about ten years and the tubes were fouled by the tar and the lamp black deposited by the waste gases coming from the coke ovens. Prior to the test the interior of the tubes was cleaned, but it was impossible to reach the exteriors in order to remove scale and soot, which fact probably reduced the boiler efficiency to some extent. The brick setting was in rather poor condition.

For the firing of this boiler the principle of "surface combustion" was used, employing the patented process and equipment of an American firm, the Surface Combustion Co. of New York. This process consists in mixing intimately the gas with the air necessary for its combustion in their exact chemical combining proportions (without excess of either air or of gas) and in projecting this mixture into a porous bed of refractory material at a speed sufficient to avoid any possibility of back firing. Almost instantaneous combustion takes place in contact with the hot surfaces of the refractory pieces composing this bed, which is rapidly brought to incandescence and serves as a source and reservoir of radiant heat.

It is in this form that heat is most penetrant and

the most rapidly absorbed by the object to be heated, although this factor has been frequently lost sight of in the application of gas burners to the firing of boilers.

In the usual boiler practice with the solid fuel fire-box not only is the boiler heated by absorption from the hot products of combustion, but also to a very considerable extent by radiation from the surface of the fuel bed. Efficiency is lost, however, in the use of solid fuel owing to the large excess of air required for complete combustion, with its consequent lowering of the flame temperature.

In the usual methods of firing boilers with gas the reverse is true and a more or less high flame temperature is obtained, but this flame is practically non-radiant. Contact of the hot gases or of the flame itself with the tubes is therefore relied upon for heating the boiler, which thus becomes to all intents and purposes practically a waste heat boiler.

If, therefore, we can utilize the efficiency of generation obtained by perfect control of a gas mixture with consequent high flame temperature, and at the same time present an efficient radiant surface to the boiler, we shall realize the combined advantages of firing with gaseous and solid fuels. This was the object in view.

Fig. 4 represents a longitudinal section of the boiler firebox transformed for the use of gas. The gas was drawn from the holder by a Roots blower, which raised it to a pressure of 12 to 16 in. of water and transmitted it through an overhead pipe line to the boiler. This pressure is employed in the inspirator A, consisting

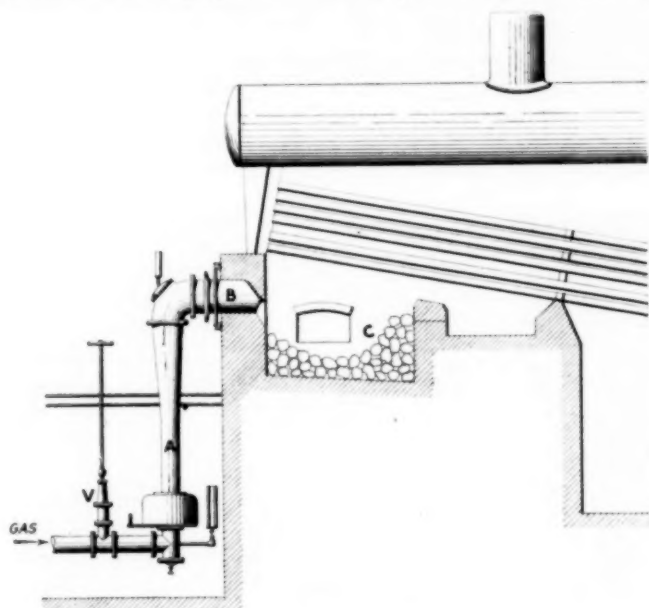


FIG. 4. LONGITUDINAL SECTION OF BOILER WITH GAS BURNER

of a gas nozzle and Venturi throat, to inspire from the atmosphere the full quantity of air necessary for the complete combustion of the gas. The high velocity of the gas and air passing through the throat completes their intimate mixture and this mixture is delivered, under pressure, to the cast-iron burner B, which discharges it at a suitable velocity into the refractory bed C. This burner is designed to present the minimum of metallic surface to the radiation from the furnace and its cross-section is sufficiently great to insure the rapid conduction of any heat absorbed to the exterior, where this heat is dissipated to the air by means of cooling fins cast integral with the body of the burner.

A feature to be noted is that the inspirator A maintains automatically constant the proportions of air and gas furnished to the burner without the need for any attention on the part of the operator. The gas consumption and therefore the rate of evaporation of the boiler may thus be regulated by the operation of a single valve V in the gas supply line as long as the quality of the gas remains approximately constant. By this means combustion under the most efficient conditions is assured—i.e., without excess of air or of gas and at the highest possible temperature.

Since a draught is not necessary for the proper operation of this system, but on the contrary is rather harmful, the boiler was isolated from its stack and a small brick flue was built against the rear of the setting, mounting to the same height as the latter, and into the bottom of this flue the waste gases were discharged from the breeching. A small damper in the

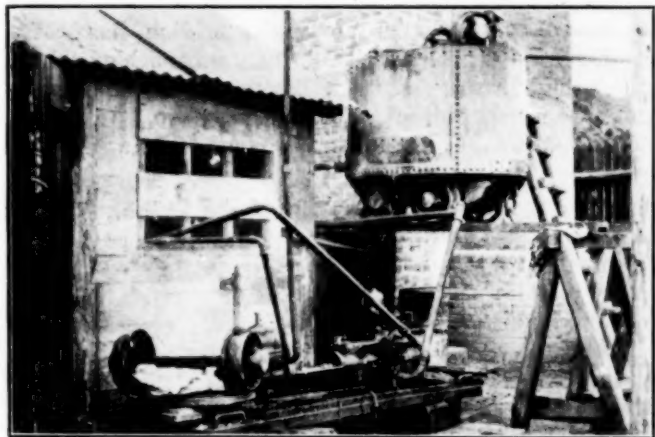


FIG. 5. EXTRA PUMP AND RESERVOIR INSTALLED TO MEET INCREASED EVAPORATION UNDER GAS FIRING

flue permitted the control of the pressure in the boiler setting.

During the period of installation of the gas-burning equipment the boiler was shut down. It was therefore entirely cold when first started up and contained water up to the normal operating level. The burner was lit quite easily by means of a small torch of oily waste. At the end of forty minutes of heating the boiler was in full operation at 120-lb. pressure as was indicated by steam escaping from the safety valve. This speed of heating demonstrates the extreme flexibility in responding to variation of load which a battery of boilers fired with gas by the surface combustion system would have.

A continuous test of the boiler at normal pressure (6.5 kilos = 93 lb.) was next attempted, but at the end of a short time it was discovered that the injector and the feed pump with which the boiler was equipped taken together were of a capacity insufficient to supply its demand when in full operation with gas firing. A second and more powerful pump was installed and a new pipe line was run doubling the capacity of the water feed. Even with these arrangements the factor limiting the production of steam was still the feed water equipment and not the boiler itself, and it was impossible to allow it to operate continuously at its maximum evaporative capacity. This latter is apparently in the neighborhood of 30 kilos of steam per hr. per sq.m. of heating surface (6.15 lb. per sq.ft.). A 24-hr. test was, however, obtained during which the

average rate was 23.75 kilos per sq.m. (4.9 lb. per sq.ft.), which is about double the normal steam production for this type of boiler. The water feed was measured by a meter known to be correct and the gas by observations made upon the gas holder, which during this test was used to supply only the boiler. The boiler was connected in upon a steam line at 6½ kilos and the pressure during the test was therefore maintained at this figure.

The average production of steam was found to be 1,900 kilos per hr. (4,200 lb.) with a gas consumption of 2,485 cu.m. (87,800 cu.ft.) per hr. measured at the holder and of 1,990 cu.m. (70,300 cu.ft.) per hr. measured by the nozzle in the inspirator. Since the temperature at the holder averaged 49 deg. C. and the gas was saturated with water vapor at this temperature, the consumption calculated by the holder was corrected for the normal pressure and temperature at the works laboratory, account being taken of the volume of water vapor contained. The above figure then becomes 1,970 cu.m. per hr. (69,600 cu.ft.) at 718 mm. and 15 deg. C., which checks quite well with the consumption calculated from the pressure at the inspirator nozzle, or, correcting to 0 deg. C. and 760 mm., 1,765 cu.m. (62,300 cu.ft.) per hr. In round figures, therefore, 1 cu.m. of gas produced 1 kg. of steam (16 cu.ft. of gas produced 1 lb. of steam). The calorific value of the gas was controlled by a Junkers calorimeter and varied during the test from 813 (minimum) to 902 (maximum) calories per cu.m. (91.3 to 101 B.t.u. per cu.ft.)—average 856 at 15 deg. C. and 718 mm. (96.3 B.t.u.). From these figures the over-all thermal efficiency of the boiler is figured as equal to 73.3 per cent. This efficiency could without doubt be improved appreciably with a clean boiler well constructed with a view to economy. The coke consumption of the producer averaged 450 kilos (1,000 lb.) per hr., 45 per cent ash content, calorific value not over 4,000 calories per kilo (7,200 B.t.u. per lb.).

The pressure and temperature of the flue gases were measured; near the bridge wall a pressure of 5 mm. water was found and immediately before the damper in the small chimney there was a suction of 5 mm. At the same place the temperature of the gases was 344 deg. C. on Dec. 20 and 354 deg. C. on Dec. 21.

Frequent flue gas analyses were made—the average of these was 17.9 per cent CO₂ with sometimes several tenths per cent CO and at other times a slight percentage of oxygen according as the gas varied in quality.

The samples taken at the bridge wall checked well with those at the breeching, showing that combustion was complete in the firebox before contact of the gas with the tubes.

In view of the satisfactory results which these first tests have given, the Société des Houillères de Montrambert et de la Béraudière is considering at present the use of producer gas for firing an important battery of boilers as a part of a large project for the utilization of its waste coal.

The installation was made by the Cie. Générale de Construction de Fours of Paris, employing the patented process and equipment of the Surface Combustion Co. of New York.

The writer wishes to acknowledge his indebtedness to M. Blache of the Société de Montrambert for much of the information above, and for the many courtesies extended to him during the tests.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Cellulose Esters.—Cellulose esters are prepared by subjecting to the usual process of esterification a cellulose derivative obtained on treating cellulose with nitric acid in the presence of nitrobenzene. In an example, cotton is treated with a mixture of nitric acid and nitrobenzene, and the product, after washing and drying, is warmed with a mixture of glacial acetic acid, acetic anhydride and bromine or other catalyst, as indicated in the parent specification; the acetate is separated in the usual manner by dilution with water, and may be hydrolyzed before or after separation. Specification 1,156—1914 is referred to. (Br. Pat. 145,524—1919. AKT. GES. FÜR ANILIN FABRIKATION, Trep-tow, Berlin, Sept. 1, 1920.)

Dust Removal From Gases and Vapors.—Dust is removed from gases and vapors by means of a rotary electric field between a number of stationary electrodes. These may be arranged about the axis of a casing, in number dependent on the kind of the field used; preferably the number of electrodes is a multiple of the number of phases of the alternating supply system, so that the field is multipolar. The electrodes may be arranged longitudinally with reference to the casing. They may be surrounded with insulating material. In the center of the rotating field there may be arranged either a rod having a higher dielectric constant than the gases, or a conductive rod connected to the neutral point of the polyphase supply system. Alternatively, a combination of these devices may be employed, in the form of a conductor surrounded by a glass cylinder, or of a stream of water. Reference is made to an arrangement having electrodes rotated by means of a rotary electro-magnetic field. (Br. Pat. 145,585—1919. W. NORTH, Hanover, Germany, Sept. 1, 1920.)

Cellulose Acetate Compositions.—A composition for use as a coating material, or in the manufacture of artificial silk or films, or as a varnish, and which can be cast or molded, consists of cellulose acetate and the aggregate of fatty acids extracted from coconut oil. A volatile solvent such as chloroform, acetone, acetylene tetrachloride, or chloroform and alcohol, is used in the manufacture of the composition; and the proportions of solvent and of fatty acid are varied according to the purpose for which the composition is to be employed. (Br. Pat. 146,212—1919. BRITISH CELLULOSE & CHEMICAL MANUFACTURING Co., London, Sept. 8, 1920.)

Obtaining Copper and Nickel Electrolytically.—In treating copper-nickel alloys or concentrates in chloride solutions, an oxidizing agent such as chlorine is introduced at intervals or continuously, so that the copper deposited at the cathode is equal in amount to that dissolved from the alloy constituting the anode. The solution may contain hydrochloric acid or a chloride such as common salt. Initially, for instance, it may be a solution of 135 g. crystallized cupric chloride per liter of 25 per cent hydrochloric acid. At a low electric

pressure, copper and nickel dissolve from the anode as sub-chlorides, no copper being deposited until a large part of the cupric chloride is reduced. No chlorine is added until deposition has brought down the proportion of copper in solution to about 4 per cent. The anode may contain 30 per cent of copper. When the solution is sufficiently rich in nickel, it is treated for the recovery of this metal by known means. (Br. Pat. 145,600—1919. P. GOLDBERG, Treptow, Berlin, Sept. 1, 1920.)

Aminophenol Derivatives.—*N*-dioxypropyl-*p*-aminophenol and its alkyl ethers are obtained by the reaction of *p*-aminophenol or its alkyl ethers with α -monochlorhydrin or glycid; the process may be effected in the presence of a neutral solvent or substances binding hydrochloric acid. Examples are given of the preparation of *n*-dioxypropyl-*p*-aminophenol, *n*-dioxypropyl-*p*-anisidine, and *n*-dioxypropyl-*p*-phenetidine; *n*-dioxypropyl-*p*-aminophenol may be used as a photographic developer, and *n*-dioxypropyl-*p*-phenetidine has therapeutic properties. Instead of α -monochlorhydrin, epichlorhydrin may be used, the resulting chloro compound being saponified by alcoholic potash. (Br. Pat. 145,614—1919. E. KOLSHORN, Dahlem, Berlin, Sept. 1, 1920.)

Isolation of the Alkaloids of *Lobelia Inflata*.—Three alkaloids, termed α -, β -, and γ -lobeline, are isolated from the crude alkaloid of *Lobelia inflata* by dissolving the crude product in hydrochloric acid, crystallizing out the difficultly-soluble hydrochloride of β -lobeline, and extracting the hydrochloride of α -lobeline from the mother liquor by means of chloroform. The chloroform solution is mixed with soda solution, the chloroform evaporated off, and the α -lobeline crystallized out; it is formulated as $C_{21}H_{27}O_2N$. The β - and γ -lobeline are not crystalline. The crude alkaloid employed may be obtained by extracting the drug by alcohol, distilling off the alcohol, dissolving the bases in dilute acid, neutralizing the acid solutions by alkali and extracting with ether; or the first extract may be made with ether or benzene. This process may be modified by using carbon tetrachloride, trichlorethylene, acetylene tetrachloride, etc., instead of chloroform for extracting α -lobeline hydrochloride from the mother liquor from which β -lobeline hydrochloride has been crystallized out. (Br. Pat. 145,621 and 145,622—1919. C. H. BOEHRINGEN SOHN, Ingelheim-on-Rhine, Germany, Sept. 1, 1920.)

Dyeing With Vat Dyes.—In dyeing animal fibers or mixed goods with vat dyes, the products of alkali hydrolyses of vegetable or animal albumins similar to protalbinic or lysalbinic acids, or their alkali salts, are added to the dye vats; brighter shades are thereby obtained and the fibers become more soft, elastic and glossy. The vats may be made neutral or slightly acid. In an example, a vat contains indigo MLB, sodium hydrosulphite, and hydrolyzed glue or casein, and is neutralized by formic acid. (Br. Pat. 145,674—1919. C. BENNERT, Grunau, near Berlin, Sept. 1, 1920.)

Artificial Threads, Ribbons, Films and Sheets.—In the manufacture of artificial threads and of ribbons, films or sheets from viscose, the solution is introduced through suitably shaped apertures into a precipitating bath consisting of waste sulphite-cellulose lye to which has been added a mineral acid or an acid salt—for example, sulphuric acid, sulphurous acid or hydrochloric acid. The waste lye obtained in the manufacture of

"sulphite ethers" may also be used. It is preferred to use a waste lye which is free from lime—for example, a sodium sulphite lye obtained when the wood is boiled with sodium bisulphite, or "by conversion of sodium salts from the waste lye of lime"; and the lye should be concentrated before use. Hardening agents such as formaldehyde or sulphate of alumina, and glue, seaweed mucilages, etc., may be added to the precipitating bath; by such additions the sensitiveness of the threads, etc., to water and their capacity for dyeing can be favorably affected. (Br. Pat. 145,627—1919. M. MUELLER, Finkenwalde, near Stettin, Sept. 1, 1920.)

Tanning.—Hides and skins are stated to be tanned by the application of constituents extracted from vegetable substances such as wood, straw and the like by means of alkaline liquids; or by formaldehyde or the salts of heavy metals such as chromium and iron, in the presence of such constituents. In an example, an extract obtained by boiling straw in soda-lye is mixed with iron-alum, in which case a yellow deposit is slowly brought down. This suspended agent is used for tanning. (Br. Pat. 145,742—1919. H. BREUER, Bonn-on-Rhine, Sept. 1, 1920.)

Refining Tin and Antimony.—Crude tin is refined by treating with dry chlorine which may be obtained by vaporizing liquid chlorine, filtering the liquid product, treating with water to decompose the chlorides of antimony, arsenic and sulphur, filtering again, and recovering tin from the pure solution of stannic chloride, for instance, by reduction to stannous chloride and electrolysis. To separate the antimony, the process is modified by heating the reaction vessel to 115-120 deg. when the antimony pentachloride is decomposed into chlorine and solid trichloride, which is therefore removed in the first filtration. In a similar manner antimony is separated from metals such as lead, and is obtained as pentachloride alone when tin does not occur among the impurities. (Br. Pat. 145,789—1919. G. BONNARD, Plombière-St. Marcel, Savoie, France, Sept. 1, 1920.)

Gallolactates, Tannolactates.—Gallolactates and tannolactates of the alkaline-earth metals, magnesium or aluminum are obtained by heating normal lactates with gallic, tannic or gallotannic acid, or basic tannates or gallates with lactic acid, in dilute alcohol, dilute acetone or mixtures thereof. Examples are given of the preparation of calcium tannolactate, calcium gallolactate, barium tannolactate, strontium tannolactate, aluminum tannolactate and magnesium tannolactate. The products are practically insoluble in water and alcohol, are slowly decomposed by dilute acids, and have therapeutic properties. (Br. Pat. 146,234—1919. E. KOLSHORN, Dahlem, Berlin, Sept. 8, 1920.)

Acyl Cyanamides.—Cyanamides of α -halogenfatty acids are obtained by reaction of halides of α -halogenfatty acids with metal cyanamides in aqueous solution or suspension. An example is given of the preparation of diethylbromacetyl cyanamide from diethylbromacetyl chloride or bromide and sodium cyanamide; α -bromisovaleryl cyanamide is also specified. Instead of sodium cyanamide, the cyanamides of calcium, silver, copper, lead, etc., may be employed. (Br. Pat. 146,289—1919. FARBENFABRIKEN VORM. F. BAYER & Co., Leverkusen, near Cologne, Sept. 15, 1920.)

Separating Mixtures of Gases.—To separate into its constituents the gas obtained in the dry distillation of fuel, the gas is first freed from tar, ammonia and

benzene, and then passed over substances having a large superficial area—for example, absorbent carbon—in which the constituents are selectively absorbed; this selective absorption is facilitated by passing the gas over a plurality of absorbent masses at different temperatures. The process is particularly applicable to the separation of ethylene, in which case it is preferred to cool the absorbent mass to a temperature between 0 and 20 deg. C.; the fraction enriched with respect to ethylene is if necessary expelled, collected and re-absorbed as before to obtain a further enrichment, and this process may be repeated. (Br. Pat. 146,332—1919. GOLDSCHMIDT AKT. GES., Essen, Sept. 15, 1920.)

Linoleum.—A composition for making linoleum consists of cellulose treated with alkaline lyes and vapor of carbon bisulphide, a rubber-like product obtained by heating glue or carbohydrates with glycerine and saponified resin. These ingredients are mixed, heated, treated with hardening agents, such as formaldehyde, chrome salts, alum, tannin, etc., and kneaded and rolled up with cork meal, sawdust or other finely powdered cellulose and coloring matter. The mass can be applied to a backing of paper or not, as desired. (Br. Pat. 146,367—1919. PHENOLEUM GES., Berlin, Sept. 15, 1920.)

Pigments.—Ultramarines and lakes are made by liberating, in a mass of china clay, alumina and/or silica; and, in the case of ultramarines, heating the product with a polysulphide of sodium; in the case of lakes, combining it with acid or basic aniline coloring matters, according as alumina or silica predominates. After treatment with acid sulphate of soda solution, sodium carbonate solution is added to precipitate alumina. The paste is filtered and the residue, after washing, is treated with sulphides of sodium and air-calcined to produce ultramarine or heated to boiling point with a solution of coloring matter to produce lakes. To obtain siliceous blues the product of the acid sulphate reaction is extracted with water to remove the aluminum sulphate and the residue treated with carbonate as before. According as acid or basic colors are employed for producing lakes, the china clay is treated to liberate alumina or silica respectively as described above. (Br. Pat. 146,402—1919. R. D. LANCE, Paris, Sept. 15, 1920.)

Zinc Sulphide; Lithopone.—Pure zinc sulphide is prepared from a soluble zinc salt, by passing sulphuretted hydrogen into the solution after the addition of such quantity of oxide or carbonate of the alkali or alkaline earth metals that the final solution when all the zinc sulphide has been precipitated remains slightly acid. The zinc solution employed may be prepared from any zinc-bearing materials, but when obtained by acting on zinc blende with hydrochloric acid and eliminating impurities, the sulphuretted hydrogen evolved during the solution of the ore may be used subsequently to precipitate the zinc sulphide. The most suitable oxide or carbonate to employ is magnesia or magnesium carbonate, since hydrochloric acid and magnesia may be regenerated, by heating with steam, from the magnesium oxychloride obtained by the addition of magnesia to the magnesium chloride solution left after the separation of the zinc sulphide. The latter is calcined at a high temperature, washed and ground, and by incorporating with barium sulphate yields lithopone. (Br. Pat. 146,410—1919. C. CLERC, Paris, and A. NIHOUL, Villex-neuve le Roi, Sept. 15, 1920.)

Program American Institute of Chemical Engineers

THE thirteenth winter meeting of the A.I.C.E. will be held at New Orleans, La., Dec. 5 to 8, after which the salt, sugar, molasses and sulphur industries in the immediate district will be visited. Reservations on train 137 leaving the Pennsylvania station, New York, at 3:40 p.m., Friday, Dec. 3, should be made with F. E. Dodge, Room 1430, The Barrett Company, 17 Battery Place, New York City. The local committees, composed of Lezin A. Becnel, Charles E. Coates, William C. Ermon and Charles S. Williamson, Jr., have arranged a little Mardi Gras of intellection which will begin with a parade through the streets of the city as follows:

SUNDAY, DECEMBER 5

2:30 P.M. Automobile ride seeing New Orleans.

MONDAY, DECEMBER 6

Meeting at the Cabildo.

9 A.M. Business session. Canvass of ballots for officers. Reports of officers and council. Reports of committees.

10 A.M. Reading of papers:

"Recent Advances in the American Sulphur Industry," Dr. R. F. Bacon.

"The Conservation of Heat Losses as Applied to Power and Heating Systems," E. R. Weidlein.

"The Sulphuric Acid Fume Problem," James R. Withrow and F. C. Vilbrandt.

"Costs—A Study of Factory Economics," A. G. Peterkin.

"Operating Variations in Sugar Production as Indicated by Some Plantation Data," Lezin A. Becnel.

2 P.M. Alternate excursions: Visit to plant of Southern Cotton Oil Co. and Sugar Refinery, or Visit to Water Filtration Plant of New Orleans.

8 P.M. Meeting at the Cabildo.

"Resources of the State of Louisiana," N. L. Alexander, Chief of Conservation Commission.

"Sewage, Water Purification and Drainage in New Orleans," George G. Earle, Chief Engineer and Superintendent, Sewerage and Water Board.

Smoker.

TUESDAY, DECEMBER 7

Meeting at the Cabildo.

9 A.M. Business session.

10 A.M. Reading of Papers:

"Lubrication of Concrete," Maximilian Toch.

"The Treatment of Sewage by Aeration in the Presence of Activated Sludge," E. Bartow.

"The Federated American Engineering Societies and the Institute," James R. Withrow.

"The Salvaging of Sag Paste," C. B. Morey.

"Studies in Evaporator Design—IV. Some Data From the Horizontal Tube Evaporator," W. L. Badger.

1:30 P.M. River trip and inspection of port facilities—tendered by the Board of Commissioners of the Port of New Orleans. The plant of the U. S. Industrial Alcohol Co. and of Penick & Ford, largest molasses canners in the world, will be visited.

7 P.M. Subscription Dinner at Antoinettes.

11 P.M. Leave New Orleans for visit to salt and sulphur mines.

WEDNESDAY, DECEMBER 8

7:08 A.M. Arrive at Lake Charles. Breakfast and auto ride to sulphur mines—tendered by the Chamber of Commerce of Lake Charles.

11:20 A.M. Leave Lake Charles for New Iberia.

2 P.M. Arrive at New Iberia.

Visit to salt mines during afternoon and returning to New Iberia at 6 P.M.

THURSDAY, DECEMBER 9

1:59 A.M. Leave New Iberia.

2:42 A.M. Arrive at Franklin. Visit to sugar factory and sugar plantation during the forenoon.

12:36 P.M. Leave Franklin.

5:50 P.M. Arrive at New Orleans.

7:40 P.M. Leave New Orleans.

FRIDAY, DECEMBER 10

11:10 A.M. Arrive at Chattanooga, Tenn. Alternate excursions: Auto trip to Lookout Mountain and nearby points of historic interest, or excursion to byproduct coke plant.

7:50 P.M. Leave Chattanooga.

SATURDAY, DECEMBER 11

9:30 A.M. Arrive Roanoke. Visit to blast furnaces of the Virginia Iron, Coal & Coke Co.

12:50 P.M. Leave Roanoke.

5:45 P.M. Arrive at Luray. Visit to the famous Caverns of Luray.

11:30 P.M. Leave Luray for Philadelphia and New York.

Ladies' Program

SUNDAY, DECEMBER 5

2:30 P.M. Automobile ride seeing New Orleans.

MONDAY, DECEMBER 6

2:30 P.M. Visit to State Museum and Vieux Carré, the old French quarter of New Orleans.

8:15 P.M. Theater party.

TUESDAY, DECEMBER 7

1:30 P. M. River trip with inspection of port facilities—tendered by Board of Commissioners of the port of New Orleans.

5:30 P.M. Return.

7 P.M. Subscription Dinner at Antoinettes.

11 P.M. Leave New Orleans for visit to salt and sulphur mines.

The remainder of the meeting—same program as for the men.

New Selling Method in Brick Industry Proposed

A new card of price extras has been adopted by a number of the leading producers of fireclay and silica brick. The plan used follows very closely the percentage method used by plate-steel manufacturers.

Shapes are classified according to cost of manufacture and each class takes a percentage extra over the base price. Thus the extra or up charge on any class of shapes automatically changes with any change in the base price.

A large number of the shapes in common use have been classified according to the costs of production, and it is expected that as further cost figures are obtained a complete list of all shapes in general use can be prepared. This is the first general change in firebrick extras since brick were selling for \$18 to \$20 in 1912 and 1913.

As labor costs represent the larger part of extra costs on special shapes, the increases in wages during the past few years made a change in extras necessary. The classification, while based on recent cost figures, follows quite closely the same percentage of the 9-in. base price as the extras in use when brick sold at \$20.

Loans Dye Collection to University

Dr. Charles E. Munroe, a widely known high explosives specialist, has loaned his collection of dyestuffs to the new chemical laboratory of the George Washington University. The collection is particularly complete.

Current Events

in the Chemical and Metallurgical Industries

Notes on European Chemical Industry

Dr. James F. Norris of the Massachusetts Institute of Technology presented a very interesting and instructive address on "Conditions of European Chemical Plants" at a joint meeting of the Western New York Section of the American Chemical Society and the Niagara Falls Section of the American Electrochemical Society held in Niagara Falls, Nov. 16.

Dr. Norris was a Colonel in the gas service of the United States Army during the war. In the summer of 1918, the gas chemists of the United States Army discovered and developed a new gas which was much more deadly than any gas which had ever been used in warfare. Owing to the possibility of a courier carrying written information falling into the hands of the enemy, Colonel Norris, who was familiar with all the details of manufacture, was intrusted with the personal delivery of these important discoveries to the Allied Commission, and at the same time was to obtain information for the Chemical Warfare Service regarding new discoveries made abroad.

The speaker first discussed the conditions of the chemical industries as he found them in England. Much praise was given the high standard and excellent quality of work produced by the individual unit both in research and in production of important chemicals essential to munitions. The lack of organization, however, was one outstanding feature which was in direct contrast to the way in which the same operations were carried on in America. There were no centralized laboratories, and the small individual laboratories, although under the direction of a capable head, were handicapped by the lack of a sufficient number of assistants and adequate equipment to undertake the problems which arose.

Dr. Norris further stated that some of the English industrial chemical plants which were constructed during the war were the most wonderful he had ever seen. An instance was given where he made a visit to one of the largest contact sulphuric acid plants at the noon hour and the factory was so spotlessly clean and orderly that the women employees ate their lunches and enjoyed their noonday rest seated around an acid tower. This particular plant was operated entirely by women, there being only one man in the entire plant organization.

After the armistice the speaker was privileged to visit German chemical plants in the British, American and French occupied zones. Many instances were cited of the ingenuity of the German chemists in meeting the problems brought about by the war and in developing new processes to use available crude materials in place of common ingredients which could not be obtained.

In one plant near Cologne, where vast quantities of sulphuric acid were made, the supply of pyrites became exhausted. An ample supply of gypsum was available, and the plant chemists stepped to the front and developed a commercial process for making sulphuric acid from gypsum, unheard of previously. Calcium sulphate

and silica sand, with a little clay added for a flux, were heated in a rotary cement kiln to bring about the necessary reaction. The gases drawn off were treated and made available for conversion into the acid, and a good grade of cement was obtained as a byproduct from the slag which came from the kilns.

All of the plants in the occupied territory were in a very orderly condition and in the best of repair. At the cessation of hostilities the plants ceased to produce, and the workmen were given employment in cleaning up and putting the plants in good order. The men in charge showed a willingness to describe in detail the processes which they used in their plant in the manufacture of gases up to the point of naming the catalyzers which were used. With German thoroughness all records of research laboratories and plant operation, as well as all the catalytic agents, were removed from the plants and sent to Berlin before the Allies reached the chemical plants along the Rhine.

The speaker gave a brief description of the process and apparatus used and some of the difficulties encountered in the German plants which manufactured ammonia by the Haber process. He corrected the erroneous report which has been in circulation to the effect that the contact towers used were buried in the ground and stated that the apparatus was all situated above ground, and that the contact towers, which were about 35 ft. high and 3 ft. in diameter, had walls 9 in. thick, in order to withstand the working pressure of hot hydrogen at 200 atmospheres.

In one of the plants visited, the manufacture of synthetic rubber in large quantities was noted. This material was stated to be superior in some respects to the natural product, especially in the manufacture of hard rubber articles.

The close connection between the dye industry and the manufacture of gases and chemicals essential to modern warfare was impressed upon the audience, as well as the future commercial possibilities of some of the hitherto obscure chemicals whose commercial production was highly developed during the war.

Dr. Norris closed his lecture with a number of slides depicting devastated France and showing the deliberate systematic destruction of the French chemical plants by the German forces as they were compelled to retreat during the closing days of the war.

Colloidal and Olfactometry

At the New York Section meeting of the American Chemical Society, Nov. 19, Reston Stevenson presented a preliminary paper on the Maximum Zones of Colloidal by Jerome Alexander, following which Ellwood Hendrick entertained the audience by an appreciation on the nose. Olfactometry has both a humorous and a serious aspect which the chemist should study in conjunction with the psychologist. It is undoubtedly of scientific and industrial importance. The value of foods and many commodities are dependent on odor and taste, which are related. The subject should not be neglected.

Calcium Arsenate Conference Is Called

That manufacturers of calcium arsenate may be more familiar with the methods used in applying this poison to the cotton plant, a conference has been called at the Chemists' Club, in New York, Dec. 6 and 7. At that meeting, which is under the auspices of the Plant Protection Institute, specialists of the Department of Agriculture will explain certain phases of the problem with which it is believed the manufacturers have not a clear understanding.

The Department of Agriculture, in its laboratory at Tallulah, La., developed the most effective method of controlling the boll weevil yet devised. It was found that the boll weevil relied upon the dew on the plant for its liquid. By dusting the leaves of the cotton plant early in the morning with calcium arsenate, it was discovered that the dew could be poisoned sufficiently to kill a large proportion of the weevils. The discovery of this method of boll weevil control led to a very rapid expansion in the demand for calcium arsenate. While the product now has been standardized so as to meet the requirements for cotton dusting, there are still a number of matters which it is believed advisable to talk over with the manufacturers.

Rochester Section, A.C.S., Holds 112th Meeting

The Rochester Section of the American Chemical Society held its 112th meeting Monday evening, Nov. 8, in the Eastman Building, University of Rochester.

Chairman Woodland announced the personnel of the various committees which will have charge of the Spring Meeting of the American Chemical Society, which is to be held in Rochester during the week of April 25, as follows:

Executive Committee: J. Ernest Woodland, Hans T. Clarke, Victor J. Chambers, Harry A. Carpenter, Harry LeB. Gray, Erle M. Billings, Florus Baxter, Herbert Eisenhart, Ivar N. Hultman, Charles F. Hutchison, William Earle, Charles W. Markus, John Howe, Benjamin V. Bush.

Entertainment Committee: Charles F. Hutchison, chairman; Otto I. Chorman.

Transportation Committee: Charles W. Markus, chairman.

Excursion Committee: William Earle, chairman.

Program Committee: Erle M. Billings, chairman; Wilbur Miller, Arthur J. Herty, Felix Elliott, John I. Crabtree, Robert Salter.

Finance Committee: Herbert Eisenhart, chairman; Frank W. Lovejoy.

Publicity Committee: Benjamin V. Bush, chairman.

Hotels Committee: Harry LeB. Gray, chairman; Lincoln Burrows.

Registration and Information: Harry A. Carpenter, chairman; William Line, Otto Cook, Florus Baxter, Mrs. Richard Kruger, Miss Gertrude Reissman, Edward Pickard.

Women's Entertainment Committee: Miss Jane P. Hannock.

Rochester Section Chemical Industrial Show: Ivar N. Hultman, chairman; M. J. Kolb, Mr. Nausman, Mr. Vieregger, Mr. Will, Mr. Story, Mr. Prince, Mr. Leary, Mr. Tucker.

Due to the increased number of National Society members from the Rochester Section, another councilship is allotted to the Section from next Jan. 1. Dr. Hans T. Clarke was unanimously elected to fill this

office. Dr. Clarke is widely known among the chemists of America. He is director of the synthetic-organic chemistry department of the Eastman Kodak Co.'s Research Laboratory. Dr. Clarke is also secretary of the Organic Division of the American Chemical Society. He is the author of many textbooks and papers dealing with organic chemistry.

Dr. John R. Murlin, director of the department of vital economics and chairman of the committee on food and nutrition, National Research Council, delivered an address before a large assembly of chemists, on "Energy and Metabolism." In this lecture the way the human body derives its energy from various classes of foods was clearly brought out by illustrations and demonstrations.

A Research Information Bureau

The National Research Council has established a research information service as a general clearing house and informational bureau for scientific and industrial research. This "service" on request supplies information concerning research problems, progress, laboratories, equipment, methods, publications, personnel, funds, etc.

Ordinarily inquiries are answered without charge. When this is impossible because of unusual difficulty in securing information, the inquirer is notified and supplied with an estimate of cost.

Much of the information assembled by this bureau is published promptly in the *Bulletin* or the "Reprint and Circular Series" of the National Research Council, but the purpose is to maintain complete up-to-date files in the general office of the Council.

Requests for information should be addressed to Research Information Service, National Research Council, 1701 Massachusetts Ave., Washington, D. C.

Engineer Needed for Non-Metals Work in the Bureau of Mines

R. B. Moore, chief chemist of the Bureau of Mines, is having considerable difficulty in locating a mining engineer with experience in non-metals work. He has been authorized to place two non-metals men at the new Tuscaloosa Experiment Station. He has found it difficult, however, to locate men with the required experience and has about reached the conclusion that it will be necessary to employ a mining engineer with good basic training who has not heretofore specialized in non-metals work.

Dr. Moore also is looking for a chemist with training in radio-activity. A chemist with such qualifications is desired to assist Dr. S. C. Lind in his radium work at the experiment station at Reno, Nev.

A.C.S. Advisory Sub-Committee Chairmen on Chemical Warfare Service Named

Chairmen have been selected for the four subdivisions of the American Chemical Society's advisory committee on Chemical Warfare Service matters. Wilder D. Bancroft, of Cornell University, will be chairman of the Research subdivision. W. K. Lewis, of the Massachusetts Institute of Technology, will head the Development subdivision. C. L. Reese, of the du Pont company, has been selected as chairman of the Production advisers, while A. S. Loevenhart, of the University of Wisconsin, will head the Physiological Investigation subdivision.

More Care Needed in the Handling of Chemicals

The Bureau of Explosives of New York City reports that during the three months ended Sept. 30, 1920, there were 624 fires or explosions on common carriers, resulting in property damage of \$222,575.22 and injury to seventeen persons.

The following is a summary of accidents causing fires, personal injuries and property loss during transportation:

Article	No.	Injuries	Property Loss
Acid, sulphuric (oil of vitriol).....	170	1	\$9,444.77
Acid, hydrochloric (muriatic).....	75	..	5,746.46
Acid, n. o. s.	70	3	2,479.78
Gasoline.....	52	6	78,867.21
Acid, nitric.....	48	..	12,503.20
Gas, compressed carbonic acid.....	38	*1	175.90
Alcohol.....	29	2	9,770.18
Charcoal.....	23	..	10,982.58
Matches, strike anywhere.....	20	..	5,656.47
Electrolyte.....	17	..	668.23
Carbon bisulphide.....	8	2	7,664.95
Varnish.....	8	..	617.75
Batteries, storage (charged with acid).....	7	..	2,335.09
Acid, acetic.....	6	..	392.82
Oil, crude petroleum.....	5	1	70,505.10
Benzene.....	4	..	161.33
Gas, compressed sulphur dioxide.....	4	..	41.00
Acid, hydrofluoric.....	3	..	83.00
Cement, rubber.....	3	..	26.18
Lacquer.....	3	..	493.08
Liquefied petroleum gas.....	3	..	†
Rubber (reclaimed and ground scrap).....	3	..	950.00
Acid, nitrating (mixed).....	2	1	70.51
Bromine.....	2	..	201.25
Cologne spirits.....	2	..	269.37
Driers, paint and Japan.....	2	..	13.36
Naphtha distillate.....	2	..	17.50
Tin, bichloride of.....	2	..	561.79
Acetone, methyl.....	1	..	93.98
Chloride of sulphur.....	1	..	15.00
Coal tar oil.....	1	..	33.20
Ether.....	1	..	7.40
Gas, compressed oxygen.....	1	..	286.00
Matches, strike on box.....	1	..	†
Oil, gas.....	1	..	81.36
Paint, liquid.....	1	..	64.00
Phosphorus, amorphous (red).....	1	..	†
Polish, furniture (liquid).....	1	..	10.00
Rags, oily.....	1	..	1,228.00
Shellac, varnish.....	1	..	56.25
Toluene.....	1	..	1.17
Totals.....	624	17	\$222,575.22

*Also one death. † Not yet reported.

Methanol Plant for British Columbia

The Acetate Products, Ltd., has completed the purchase of the old Liverpool Cannery plant at South Westminster, B. C., and will commence the installation of an up-to-date methanol (wood alcohol) plant at once. The company has obtained a concession for the cutting of alder over a considerable area along the Fraser and Pitt rivers, and, besides methanol, will make acetate of lime, charcoal and several wood-tar products. This is the first methanol plant to be erected on the Canadian Pacific coast; there are to be two plants of a similar nature in eastern Canada, one in Ontario and the other in Quebec.

Fish and vegetables formerly were canned at the Liverpool Cannery, but the plant has been idle for more than two years. The Acetate Products, Ltd., has announced that it will purchase as much machinery as possible locally, but a considerable proportion will have to be purchased in the East, as it is not manufactured on the coast.

Wood Preservatives Must Be Water Soluble*

Effectiveness of substances in preserving wood is dependent on their solubility in water, at least to the extent of producing a toxic water solution. It would seem reasonable to expect that any material which is poisonous enough to kill an organism of any kind must

necessarily be soluble in the body fluids of that organism; and the chief body fluid of timber-destroying fungi and wood borers is water. With very poisonous materials this solubility need not be great; in fact, 1 part in 1,000,000 may be sufficient if the material is poisonous enough.

Wood preservatives now in use are of two distinct types—inorganic salts, such as zinc chloride, which are very soluble in water; and oils, such as the creosotes, which are generally considered to be insoluble. The solubility of creosote is usually considered so slight as to be neglected, but experiments indicate that certain constituents of creosote are sufficiently soluble in water to render it toxic, the others insoluble in water and hence not toxic. The non-toxic oils act as a reservoir for the toxic oils and feed them slowly to the moisture in the wood.

The difference between oil preservatives and inorganic salt preservatives, as far as this theory is concerned, is in their method of retaining the reserve supply of poison. Zinc chloride has no reserve supply, all the material being soluble in the usual amount of moisture present in air-dry wood. Sodium fluoride may have a reserve supply in the form of solid crystals, if applied in a saturated solution. Creosote oil may have a considerable reserve supply stored in the oil itself, this supply being fed to the wood as needed.

Standard Packages for Reagents

The Committee on Guaranteed Reagents of the American Chemical Society is recommending standard packages for reagents in the metric units. The effort is to eliminate wide varieties of packages so that purchases will be made for any particular material in only two or three standard size units which will be 500 grams instead of a pound; 200 grams instead of a half pound, 25 grams instead of the ounce. The chairman of the committee says: "I am hoping that enough orders will be placed in metric units within the next six months to change the basis of purchase within that time. It can be done if all those who have expressed themselves as preferring the metric units will use them in this connection."

Recommended lists are being submitted by the committee for the guidance of purchasers and it hopes that after some experience on this basis satisfactory agreement can be reached that will permit much greater uniformity than has previously prevailed.

Washington Section, A.C.S., Holds Meeting

"The Chemistry of Vitamines" was the subject of the presidential address by Dr. Atherton Seidell before the Chemical Society of Washington, D. C., Nov. 11. Dr. Seidell gave the history of efforts to isolate pure vitamins and described the present status of our knowledge of these substances. He pointed out that at present it appears more likely that vitamins are in nature fairly similar to enzymes rather than that they are pure chemical compounds in the usual sense.

Officers of the Chemical Society of Washington (local section of the American Chemical Society) were elected at this meeting, as follows:

President, William Blum, Bureau of Standards; secretary, J. B. Reed, Bureau of Chemistry; treasurer, F. P. Dewey, Bureau of the Mint, and councillors to the A.C.S., R. B. Sosman, W. D. Collins, W. M. Clark, F. W. Smither and A. Seidell.

*From Technical Notes, Forest Products Laboratory.

Relativity and Life

On Thursday evening, Nov. 18, members and guests of the Philadelphia Section of the American Chemical Society filled the auditorium of the Engineers' Club to hear Ellwood Hendrick, president of the Chemists' Club, New York, and consulting editor of *CHEMICAL & METALLURGICAL ENGINEERING*, speak on "Relativity and Life."

In spite of the fact that not more than a dozen men can follow the mathematical paths by which Albert Einstein arrived at his theory of relativity, the principle itself is most simple and is capable of universal application. Mr. Hendrick developed in some detail the thought that this doctrine should not be confined to the realm of cosmic physics, but should be made a controlling factor in our daily lives. The concept that everything is relative—that nothing is absolute—that our every thought and deed is influenced by our relations with others—leads to a system of ethics which the speaker showed could be applied to politics, religion, business and law with benefit to all concerned. Carrying the idea further, it is possible to determine the dimensions of many of the factors involved in our social relations, and we thus have a means of measuring these in an approximately quantitative manner at least. It has often been remarked that scientists and engineers seem reluctant to take part in public affairs. Perhaps they have felt that the gulf between was too wide for them to span. If so, it seems that we have in Einstein's theory of relativity the bridge which will unite the fields of science, engineering and politics.

Book Reviews

CHEMICAL REACTIONS. By K. G. Falk. xiv + 211 pp. New York: D. Van Nostrand Co., 1920. Price \$3.

Contrary to the expectation produced by the title, one does not find the law of mass action, the theorem of Le Chatelier, the principle of maximum work or the phase rule. The effect of the intensity factors of energy in the displacement and determination of equilibrium is not considered. The intensity factor of chemical energy (affinity) is mentioned in the first few pages and its importance stated, but throughout the book the capacity factor (valence) is used instead. This, however, criticises merely the outside of the book and classifies the inside. The subject treated is the application of the J. J. Thomson electron theory of valence to E. C. C. Baly's addition theory of chemical reaction.

The author is particularly qualified by his publications and researches to present the electron theory of valence. He develops and applies this theory admirably. With electronic structural formulæ, reactions are pictured as they would occur when the first step in a reaction is the union of the reacting substances. The addition compound is generally instable and temporary and a rearrangement gives one or more of several possible resultants. The methods of determining electronic formulæ, their significance and the chemical considerations determining the resulting rearrangement are fully discussed. Electrochemical reactions are omitted. Some inorganic reactions are presented but the book will be valuable chiefly to the organic chemist. Reaction is represented as electronic rather than ionic. A distinct contribution to the ionic theory is made by the explanation of the importance of the solvent.

Every modern organic chemist should read this book as an application of modern physical chemistry to organic chemistry. It is ingenious and profound and an amazing wealth of modern research has been digested and incorporated. The author's style is that of a verbal discussion such as a professor's lecture to advanced students. Many

readers will regret that the exposition is not more gradual and that postulates, theories and experimental evidence are not more obviously classified. On page 43, line 4 is one of the rare typographical errors and on page 133, line 21, hydroxyl should be written instead of hydrogen. The book is printed in large type and the elaborate formulæ are distinct.

RESTON STEVENSON.

SELLING YOUR SERVICES. By George Conover Pearson. 238 pp. New York: Jordan-Goodwin Corporation; 1920. Price, \$2.

In scarcely any field of human activity is the engineer less proficient, on the average, than in selling his services, and in scarcely any other would he find, on the average, greater financial profit through effort expended to increase his proficiency. If what he needs is impetus, inspiration, or in the language of the day "some pep," he will find Mr. Pearson's little book valuable, but if he goes about it after the fashion of any other engineering problem, analyzing it into its component factors, and getting a firm grasp on the fundamental principles, the style and presentation of the subject matter is not unlikely to be unattractive to him. The author principally has in his mind the securing of a position as an executive in general business, and not only does not recognize that positions of a different character call for variations of method, but says plainly that the same method can be applied to any kind of position. Perhaps this is a natural error on the part of the author because of the tendency on the part of industry to attempt to standardize human beings, undeterred by the fact that it is a quite impossible task. Just at present the executive type of mind is the fashion and the technical expert is only considered to have exhibited the full measure of his powers when he has demonstrated his executive ability. Too many scientific men have demonstrated their value to society without possessing executive ability to render assent possible to such a view. However, from reading the book, the technical man may gather useful suggestions as to the most effective procedure in selling his services when the need for doing so may arise.

T. T. READ.

Personal

Dr. ERNEST ANDERSON, for the past three years professor of agricultural chemistry in Transvaal University College, Pretoria, has been appointed professor of general chemistry in the University of Nebraska, Lincoln, Neb.

Dr. W. R. BLOW, professor of biochemistry at the University of California, addressed the California Section of the A.C.S. recently on the subject of "Fat Metabolism."

R. T. CHAMBERLAIN, professor of geology at the University of Chicago, who has recently returned from a trip in the South Seas, spoke before the Chicago Chemists' Club recently on "The Coral Reefs at Samoa."

GEORGE P. GRAY has resigned his position as assistant professor of entomology and chemistry at the University of California, to become chief of the division of chemistry of the newly established Department of Agriculture of the State of California, Sacramento, Cal.

Dr. L. O. GRONDAHL has resigned as professor of physics at Carnegie Institute of Technology, Pittsburgh, Pa., to become director of research with the Union Switch & Signal Co., Swissvale, Pa.

NORMAN C. HILL, who for almost five years was superintendent of acid plants at the Naval Proving Ground, Indian Head, Md., resigned that position on Oct. 4 to become superintendent of acid production with the Monsanto Chemical Works at East St. Louis, Ill. He will have direct charge of contact and chamber plants, muriatic, chlorosulphonic acid, nitric acid and zinc chloride manufacture.

L. E. JACKSON has resigned as chemist and chemical engineer with the Empire Gas & Fuel Co., Bartlesville, Okla., to accept a fellowship at the Mellon Institute.

VICTOR KADISH has resigned the position of superintend-

ent of the Milwaukee Patent Leather Co. to open an office as consulting chemist in the Trust Building, Milwaukee, Wis. He will specialize on leather problems.

GEORGE H. KIMBER has left the United States Color & Chemical Co., Ashland, Mass., and is now with the Semet-Solvay Co., Syracuse, N. Y.

CLIFFORD S. LEONARD, who received the degree of Ph.D. from the University of Wisconsin in June, has accepted one of the traveling fellowships of the American Scandinavian Foundation, and has sailed for Sweden. He will study chemistry at the Karolin Institute, Stockholm.

Colonel C. W. OTWELL, recently transferred from the Corps of Engineers to the Chemical Warfare Service, is to take command of the proving ground at Lakehurst, N. J.

S. W. PARR, professor of applied chemistry at Illinois University, delivered a talk before the Western Society of Engineers, Chicago, Wednesday, Nov. 10, on "Fuels of the Future."

CHARLES L. PARSONS, secretary of the American Chemical Society, was in Chicago recently.

WILLIAM N. PRITCHARD, formerly with the Calco Co., Bound Brook, N. J., and Harold Hurst, formerly with the LeDoux Co., are now on the staff of the department of chemistry, Cooper Union, New York.

SAUVEUR & BOYLSTON, metallurgical engineers, Abbott Bldg., Harvard Sq., Cambridge, Mass., announce the appointment of H. M. Boylston to the chair of metallurgy in charge of the mining engineering department, Case School of Applied Science, Cleveland, Ohio, where he will be available for consultation. The firm will continue its laboratories and offices in Cambridge under the supervision of Prof. Albert Sauveur.

O. R. SWEENEY has changed his position from professor of chemical engineering and head of the department of chemical engineering at the University of Cincinnati, to professor of chemical engineering and head of the department of chemical engineering at Iowa State College, Ames, Iowa.

L. J. WALDBAUER has left the Redpath Laboratory of E. I. du Pont de Nemours & Co., to be instructor in chemistry at the University of Maine, Orono, Me.

T. K. WEBSTER, vice-president of the Fansteel Products Co., Chicago, has recently returned from a month's sojourn in England.

JOHN A. WILSON has been retained by the Milwaukee Sewage Commission to direct investigations on the dehydration of sludge.

ROBERT F. WOOD has severed his connection with the Sandusky Foundry & Machine Co., and is now with the Monel Metal Products Corp., Bayonne, N. J., as metallurgist.

R. ZELLER has resigned his position as vice-president, secretary and plant manager of the Egyptian Lacquer Mfg. Co., New York City, and is now with the Zeller Lacquer Mfg. Co., Inc.

The following gentlemen have just been elected directors of the Research Corporation: Dr. A. A. Hamerschlag, president of the Carnegie Institute of Technology, Pittsburgh; John C. Pennie, patent attorney, 35 Nassau St., New York; and Ellwood Hendrick, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING. The other directors are: E. H. Hooker, of the Hooker Electrochemical Co., Niagara Falls, N. Y.; Benjamin B. Lawrence, consulting mining engineer, New York City; Charles A. Stone, president of the American International Corp., New York City; Arthur D. Little, of Arthur D. Little, Inc., Cambridge, Mass.; T. Coleman du Pont, of New York City; Frederick A. Goetze, treasurer of Columbia University, New York City; John B. Pine, attorney, New York City; Charles D. Wolcott, secretary of the Smithsonian Institution, Washington, D. C.; George F. Kunz, Tiffany & Co., New York City; Otto H. Kahn, banker, New York City; John J. Carty, of the American Telephone & Telegraph Co., New York City, and Howard Poillon, mining engineer, New York City. E. H. Hooker is president of the Research Corporation and Benjamin B. Lawrence is treasurer.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Nov. 22, 1920.

Continued slackening of industrial wheels at various points throughout the country has been greatly reflected in the consuming demand during the past week. Irregular trading of a small character is reported and buying power is not specially emphasized in any important direction. Large holders are granting concessions on some items in order to stimulate business, while others are cutting prices in a spirit of competition. In some instances dealers have declared intentions of keeping out of the market until signs of a more stable market present themselves. In short, the spot market is purely a buyers' affair. Smaller chemicals have shown greater weakness than the larger, and it is asserted that the rapidity of declines in several directions speaks well for the establishment of a permanent trading basis in the near future.

Caustic soda was rather quiet during the week and the market weakened on the arrival of large quantities from leading New England mills. Spot prices ranged from \$4@\$.15 per 100 lb. Bichromate soda touched a new low level for the year when sales were made at 9c. per lb. Buyers showed no inclination even at these prices to buy freely. Prussiate of soda suffered another sharp decline owing to strong selling competition and reached its lowest price of the year. Trading did not assume active dimensions and holders were eager to do business ranging from 19@20c. per lb. Heavy calcined magnesias is bringing 8@8½c. per lb., the inside figure being the lowest on record for the year. The technical variety is moving quietly at 11c. per lb. Formaldehyde buyers showed no disposition to operate in a large way, regardless of the acute price concessions. Prices last heard ranged from 18@19c. per lb. White arsenic sales were reported in larger volume than any on the list. In one quarter a sale was consummated for 50 long tons November-December shipment at 11½c. per lb. This figure was the cheapest heard in the past few months and could not be judged as the prevailing market price.

COAL-TAR PRODUCTS

The market for the crude products has reflected a steady tendency during the past week, with reports from leading producers showing their output scarcely above the consuming demand. Prospects of any further declines seem to have disappeared and the present market is toward firmness. C.P. benzene in some quarters is available in tank cars at 33c. per gal., and in drums at 36c. The 90 per cent is 28c. in tank cars and 30c. in drums. Toluene is heard at 26@34c. per gal. Solvent naphtha retains its steady tendency at 30@35c. per gal. Cresylic acid is easy and available at 95c.@\$1.15 per gal., depending on grade.

Intermediates suffered some sharp declines owing to persistent reports that tanneries and textile mills have accumulated large supplies of colors and dyes. Dealers have thrown goods on the market at new low levels with only little response from leading consumers. Beta naphthol technical reached its lowest price of the year when sales were recorded at 40c. per lb. Supplies of dimethylaniline are easy and not much interest is shown even with offerings at 72@75c. per lb. Demand for paranitraniline is quiet, with reports current of low stocks on spot. Prices ranged from \$1.10@\$1.15 per lb. Diethylaniline supplies are reported in fair accumulation with the demand small and the market holding steady at prices between \$1.50 and \$1.60 per lb. Monochlorbenzene tone is easy and sellers quote 14@16c. per lb. The demand is limited to small lots.

CRUDE RUBBER

The market for crude rubber continues to present a quiet and dull appearance. Leading consumers are still out of the market and factors report only small lot sales. Heavy

liquidations have been reported around town and there seems to be little hope for an immediate improvement in the situation. Prices continue mostly nominal. Offerings of *ribbed smoked sheets* on spot are noted at 18½c. per lb. and it is intimated that firm bids of 18½c. per lb. would probably be accepted. December prices are quoted at 18½c. per lb. Deliveries over next year remain unchanged and featureless at 21c. per lb. for January-March, 23c. for April-June and 25½c. for July-December.

PHILIP S. TILDEN SAYS:

The following extract is an expression of the present chemical market delivered recently before the members of the Philadelphia Chemical Club, by Philip S. Tilden, sales director of the heavy chemical and acid department of E. I. du Pont de Nemours & Co.:

"As to the future of the chemical business, God knows. If I knew, I would go out and play golf and come back and reap the benefits at the proper time; but again there should be no cause for pessimism. You cannot take care of 111,000,000 people which make up the United States without an expansion in the chemical business. We do not often realize that everything we have on has been treated in some way by chemicals, and without chemicals we could not exist. Therefore, we must forget the temporary dullness and work for the future. Again this is no time for contraction. I do not mean that we should needlessly expand, but we should be ready for what we know is in store for us in the line of increased demands for the articles which we represent. I think less profiteering was seen in the chemical market than in other lines of industry. The bichromates, prussiates and cyanides have, however, given us many sleepless nights since the war began, and we must now bring ourselves to realize that we must again come down to earth and continue in the chemical business along lines in which it is ordinarily conducted. If the buyers realize that we are again on a permanent basis, it appears to me that buying would be resumed in this business as well as in others."

It is evident, from these remarks, that leaders in the chemical industry believe that the time is already past when ruthless profiteers would again try to domineer the chemical market with exorbitant prices. American producers must now look forward to our domestic consumers for the preservation of the chemical industry. There must be more stability and normality in the present market to tempt buyers into active trading. It is to be hoped that stability will be a reality in the near future.

The Baltimore Market

Baltimore, Md., Nov. 20, 1920.

The local market on fertilizer raw materials continues dull, with buyers showing little interest in offerings. About the only sales that are being effected are in distressed lots which can be secured at prices below the nominal market.

The spring prices for bagged goods have finally been approved at Washington as follows: \$5 per unit of ammonia; 80c. per unit available phosphoric acid; \$2.25 per unit of potash.

The fertilizer manufacturers are sending their salesmen out this week to begin campaigning for spring business; their success in securing orders will be the controlling factor in the resumption of movement of raw materials.

ACID PHOSPHATE

The market on this commodity may be quoted nominally at \$17.50 per ton, basis 16 per cent, bulk run-of-pile. A firm offering, however, has been reported this week at \$17 on the basis mentioned above. It is thought by many that the acid phosphate market will show a slight improvement shortly.

POTASH

Shipments of foreign potash continue to arrive intermittently. Contracts for Alsatian salts for forward delivery are now being booked. Arrival of the full quota, however, is uncertain at this time. German potash is coming in more slowly, although arrivals of cargoes are being noted from

time to time at the various ports. A good portion of these German salts are being shipped by the merchants in the United Kingdom. Up to this time we have had no report that Nebraska producers have booked contracts for future delivery. The market on the various potash salts may be quoted nominally: muriate \$2.10 per unit, manure salts and kainit at \$1.90 per unit, all c.i.f. Atlantic ports. A sale was reported this week, at a Southern point, of a round lot of manure salts at \$1.95 per unit c.i.f. Southern port.

NITRATE OF SODA

This commodity is quoted nominally at \$3 per 100 lb., ex vessel Northern and Southern Atlantic ports. It is quite possible that the importers would entertain a bid somewhat lower than this price on a round tonnage for delivery prior to Jan. 1. A number of fertilizer manufacturers secured their requirements for the spring during last summer at a price averaging \$3.70 per 100 lb.

SULPHATE OF AMMONIA

The last price noted on this material was a resale at \$4.50 per 100 lb., bulk basis 25 per cent, f.o.b. shipping point. A comparatively small tonnage of this material is to be had on the open market.

FISH SCRAP

Many of the factories on the Chesapeake Bay have discontinued fishing for the year owing to the recent light catch on the approach of cold weather. Due to indifference on the part of buyers machine-dried, unground fish scrap has again declined and may be quoted today nominally at \$4 per unit of ammonia and 10c. per unit b.p.l. delivered Baltimore, in buyers' bags, for prompt shipment. There is a rather heavy accumulated stock of menhaden fish oil at this time, and the market on this commodity has also dropped and is today offered nominally at 40c. per gallon in tierces.

The Iron and Steel Market

Pittsburgh, Pa., Nov. 19, 1920.

Steel production by the independents is decreasing at a decidedly rapid rate, as many are not operating at over 50 or 60 per cent of capacity. In occasional instances the production of ingots is extremely light, but with finishing mills operating at a moderate rate on semi-finished steel accumulated during the period of car shortage. The Steel Corporation's operations are well maintained and are probably at a higher rate than that of last August and September, when there was considerable restriction on account of fuel shortage.

There is a fresh run of cancellations of finished steel contracts and of instructions to suspend or postpone contract shipments. Possibly on this account, or possibly because so little business is offered as an incentive, the independent mills as a class show little disposition to reduce their prices. Bars, shapes and plates are regarded as being on the basis of 3c. in the independent market, when the Steel Corporation prices are 2.35c., 2.45c. and 2.65c. respectively. Even sheets, which were declining continuously and rapidly for weeks, have shown little recession in the past week. Tubular goods remain very strong.

STEEL AND OTHER INDUSTRIES

Opinions in the steel trade as to the future of the market have been undergoing a rapid change of late, in the direction of expectations that the readjustment and depression will last longer than was expected. The opinions commonly expressed a few weeks ago were based upon what was observed in the steel industry rather than upon what was occurring in industry and finance generally. It was noted that the consumptive demand for steel kept up rather well, and it was inferred that with a little readjustment in prices and perhaps a period of a few weeks of slack operation the market would be found adjusted and buyers would begin taking hold again. Predictions were quite common, though by no means universal, that the decline in pig iron and steel prices would have run its course by March or April, with a buying movement and a stiffening in prices immediately following.

No such view is now entertained. It is now recognized that the reason the manufacture and consumption of steel continued heavy long after many industries had become almost idle was not because the industry was entitled to continued exemption but because its momentum had carried it for a longer period of time. The force had been spent more slowly because there had been the succession of restrictive influences to production—the steel strike that began Sept. 22, 1919, then the coal strike and then the railroad strikes. The present view is that the iron and steel trade will have to undergo readjustment the same as other industries, and that it cannot become really active again until other industries are active. It is possible, but improbable, that the iron and steel industry could readjust so rapidly as to be ready for business on the new basis within a very few months, but even if so it would have to wait until industrial and financial conditions generally are readjusted, and the process will admittedly take quite a while.

The present view as to the iron and steel future is that through a large part of next year there will be more or less industrial depression, with a real revival in iron and steel buying being early if it occurs in the fall of the year. The present stagnation in buying cannot of course continue for any length of time. There is always consumption, but just after a period of high pressure almost all buyers are able to refrain from making any fresh commitments for a time. Such buying will be from hand to mouth and will not be broad enough to cause prices to advance or stiffen from whatever level they may have declined to.

PIG IRON PRICES

Despite the firmer attitude the merchant furnaces recently suggested they intended to display, waiting for actual inquiries of importance before making further cuts in prices, the pig iron market has slid off again, bessemer being off \$2 and basic and foundry \$1, making the market now quotable as follows: bessemer, \$40; basic, \$37.50; foundry, \$39 f.o.b. valley furnaces, freight to Pittsburgh being \$1.96. The declines occurred with little incentive being presented by way of inquiry. There was hardly any bessemer sold and little basic, while the \$39 price on foundry iron was developed by a sale of 500 tons, for delivery through the remainder of the year to the Standard Sanitary Manufacturing Co.

Declines from the top points reached last August are now \$8.50 in bessemer and \$11 each in basic and foundry. Predictions common only a few weeks ago that the bottom would be reached at between \$30 and \$35 have disappeared. The debate now is as to whether or not the market will break through the Industrial Board prices. Those prices were \$25.75 for basic, \$26.75 for foundry and \$27.95 for bessemer. The furnacemen grudgingly adopted them when promulgated March 21, 1919, and adhered to them for more than six months. It is quite impossible now to make any appraisal as to where the pig iron market can go, because the coke market has refused to give an idea as to where it will go, Connellsville furnace coke for spot shipment being scarcely down to \$8, while in April, 1919, it sold at \$3.60 and in May, 1915, at \$1.50.

STEEL PRICES

It is now not entirely improbable that eventually, and before there is any general upward swing, even the United States Steel Corporation's steel prices will decline. For a long time the trade generally held to the view that whenever a readjustment in steel prices should come it would consist simply in independent prices declining to the Steel Corporation or Industrial Board level. The independents are holding their prices above the Steel Corporation level so well that it seems improbable they will decline to the corporation level until conditions require that all prices should decline. The corporation would have no occasion to reduce its prices for a long time. Even though its order books should not permit it to operate full, it would be operating at much higher rates than the independents, nor would the corporation be much disposed to reduce its prices without a reduction in costs, but the general readjustment in the country is so extensive that reductions in costs are not improbable eventually.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.	—	\$0.65 - \$0.75
Acetone.....	lb.	\$0.15 - \$0.16	.16 - .17
Acid, acetic, 28 per cent.....	100 lbs.	3.50 - 3.75	4.00 - 4.50
Acetic, 56 per cent.....	100 lbs.	7.50 - 8.00	8.50 - 9.50
Acetic, glacial, 99½ per cent, carboy	100 lbs.	11.50 - 12.00	12.50 -
Boric, crystals.....	lb.	.15 - .16	.16 - .19
Boric, powder.....	lb.	.15 - .16	.17 - .20
Citric.....	lb.	—	.52 - .54
Hydrochloric (nominal).....	100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent (nominal).....	lb.	.15 - .16	.16 - .18
Lactic, 44 per cent tech.....	lb.	.10 - .11	.12 - .16
Lactic, 22 per cent tech.....	lb.	.04 - .05	.06 - .07
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.	—	.08 - .08½
Nitric, 40 deg.....	lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg.....	lb.	.07 - .08	.08 - .09
Oxalic, crystals.....	lb.	.0 - .20	.21 - .21½
Phosphoric, Ortho, 50 per cent solution.....	lb.	.19 - .20	.21 - .22
Picric.....	lb.	.28 - .35	.40 - .50
Pyrogallol, resublimed.....	lb.	2.30 - 2.55	2.60 - 2.65
Sulphuric, 60 deg., tank cars.....	ton	11.00 - 12.00	—
Sulphuric, 60 deg., drums.....	ton	—	—
Sulphuric, 66 deg., tank cars.....	ton	18.00 - 19.00	—
Sulphuric, 66 deg., drums.....	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	27.00 - 30.00	37.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	28.00 - 30.00	38.00 - 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.....	lb.	1.45 - 1.50	1.55 - 1.65
Tannic (tech).....	lb.	.60 - .70	.80 - .90
Tartaric, crystals.....	lb.	—	.49 - .52
Tungstic, per lb. of WO.....	lb.	—	1.20 - 1.40
Alcohol, Ethyl (nominal).....	gal.	—	5.75 - 6.25
Alcohol, Methyl (see methanol).....	—	—	.82 - .85
Alcohol, denatured, 188 proof (nominal).....	gal.	—	.88 - .90
Alcohol, denatured, 190 proof (nominal).....	gal.	—	.95 - .95½
Alum, ammonia lump.....	lb.	.04 - .04½	.05 - .05½
Alum, potash lump.....	lb.	.05 - .06	.06 - .07
Alum, chrome lump.....	lb.	.14 - .15	.16 - .17
Aluminum sulphate, commercial.....	lb.	.03 - .03½	.04 - .04½
Aluminum sulphate, iron free.....	lb.	.04 - .04½	.04 - .05
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.08 - .09	.09 - .10
Ammonia, anhydrous, cylinders (100-150 lb.).....	lb.	.33 - .35	.36 - .38
Ammonium carbonate, powder.....	lb.	.14 - .14½	.14 - .15
Ammonium chloride, granular (white sulphamonic) (nominal).....	lb.	.13 - .13½	.14 - .14½
Ammonium chloride, granular (gray sulphamonic).....	lb.	.11 - .12	.12 - .13
Ammonium nitrate.....	lb.	.11 - .12	.13 - .14
Ammonium sulphate.....	lb.	.04 - .04½	.05 - .05½
Amylacetate.....	gal.	—	4.50 - 5.00
Amylacetate tech.....	gal.	—	4.00 - 4.20
Arsenic, oxide, lumps (white arsenic).....	lb.	.13 - .13½	.13 - .14
Arsenic, sulphide, powdered (red arsenic).....	lb.	.16 - .16½	.16 - .17
Barium chloride.....	ton	90.00 - 95.00	100.00 - 105.00
Barium dioxide (peroxide).....	lb.	.24 - .25	.25 - .27
Barium nitrate.....	lb.	.12 - .12½	.13 - .13½
Barium sulphate (precip.) (blanc fixe).....	lb.	.04 - .05	.05 - .06
Bleaching powder (see calcium hypochlorite).....	—	—	—
Blue vitriol (see copper sulphate).....	—	—	—
Borax (see sodium borate).....	—	—	—
Bromine (see sulphur, roll).....	—	—	—
Bromine.....	lb.	.70 - .80	.85 - .90
Calcium acetate.....	100 lbs.	3.50 - 3.55	—
Calcium carbide.....	lb.	.05 - .06	.06 - .06½
Calcium chloride, fused, lump.....	ton	30.00 - 32.00	33.00 - 35.00
Calcium chloride, granulated.....	lb.	.02 - .02½	.03 - .03½
Calcium hypochlorite (bleaching powder).....	lb.	.05 - .05½	.06 - .06½
Calcium peroxide.....	lb.	—	1.50 - 1.70
Calcium phosphate, monobasic.....	lb.	—	.75 - .80
Calcium sulphate, pure.....	lb.	—	.25 - .30
Camphor.....	lb.	—	1.05 - 1.10
Carbon bisulphide.....	lb.	.08 - .09	.10 - .11
Carbon tetrachloride, drums.....	lb.	.13 - .13½	.14 - .14½
Carbonyl chloride (phosgene).....	lb.	—	1.25 - 1.50
Caustic potash (see potassium hydroxide).....	—	—	—
Caustic soda (see sodium hydroxide).....	—	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.09 - .09½	.10 - .10½
Chloroform.....	lb.	—	.43 - .50
Cobalt oxide.....	lb.	—	3.90 - 4.00
Copperas (see iron sulphate).....	—	—	—
Copper carbonate, green precipitate.....	lb.	.27 - .28	.29 - .31
Copper cyanide.....	lb.	—	.65 - .70
Copper sulphate, crystals.....	lb.	.07 - .08	.08 - .09
Cream of tartar (see potassium bitartrate).....	—	—	—
Epsom salt (see magnesium sulphate).....	—	—	—
Ethyl Acetate Com. 85%.....	gal.	—	1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....	—	—	—
Formaldehyde, 40 per cent (nominal).....	lb.	.18 - .18½	.19 - .20
Fusel oil, ref.....	gal.	—	4.25 - 4.50
Fusel oil, crude (nominal).....	gal.	—	3.25 - 3.50
Glauber's salt (see sodium sulphate).....	—	—	—
Glycerine, C. P. drums extra.....	lb.	—	.23 - .24
Iodine, resublimed.....	lb.	—	4.30 - 4.40
Iron oxide, red.....	lb.	—	.15 - .25
Iron sulphate (copperas).....	100 lbs.	2.25 - 2.50	2.75 - 3.00
Lead acetate, normal.....	lb.	—	.12 - .16
Lead arsenate (paste).....	lb.	.13 - .14	.14 - .15
Lead nitrate, crystals.....	lb.	—	.90 - 1.00
Litharge.....	lb.	.12 - .12½	.13 - .13½
Lithium carbonate.....	lb.	—	1.50 -
Magnesium carbonate, technical.....	lb.	.11 - .12	.12 - .13
Magnesium sulphate, U. S. P.....	100 lb.	3.00 - 3.25	—
Magnesium sulphate, commercial.....	100 lb.	—	3.50 - 3.60
Methanol, 95%.....	gal.	—	1.85 - 1.90
Methanol, pure.....	gal.	—	2.30 - 2.35
Nickel salt, double.....	lb.	—	.12 - .12½
Nickel salt, single.....	lb.	—	.13 - .13½
Phosgene (see carbonyl chloride).....	—	—	—
Phosphorus, red.....	lb.	.50 - .55	.60 - .65
Phosphorus, yellow.....	lb.	—	.35 - .37
Potassium bichromate.....	lb.	.22 - .22½	.22 - .23

	Carlota	Less Carlota
Potassium bitartrate (cream of tartar).....lb.	\$0.45 - \$0.47	\$0.48 - \$0.49
Potassium bromide, granular.....lb.	50 - 55	56 - 60
Potassium carbonate, U. S. P.....lb.	131 - 14	141 - 15
Potassium carbonate, crude.....lb.	18 - 18 1/2	19 - 20
Potassium chlorate, crystals.....lb.	161 - 16 1/2	17 - 17 1/2
Potassium hydroxide (caustic potash).....lb.	3.20 - 3.30	3.30 - 3.40
Potassium iodide.....lb.	14 - 16	16 1/2 - 17
Potassium nitrate.....lb.	60 - 63	65 - 70
Potassium permanganate.....lb.	73 - 75	78 - 80
Potassium prussiate, red.....lb.	34 - 35	35 1/2 - 36
Potassium prussiate, yellow.....lb.	240.00 - 255.00	
Potassium sulphate (powdered).....ton		
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake.....ton	52.00 - 55.00	
Silver cyanide (nominal).....oz.	1.25 - 1.30	
Silver nitrate (nominal).....oz.	60 - 62	
Soda ash, light.....100 lb.	2.05 - 2.10	2.20 - 2.40
Soda ash, dense.....100 lb.	2.50 - 2.75	3.00 - 3.25
Sodium acetate.....lb.	08 - 08 1/2	08 1/2 - 09
Sodium bicarbonate.....100 lb.	2.90 - 3.00	3.25 - 3.50
Sodium bichromate.....lb.	09 - 09 1/2	09 1/2 - 10
Sodium bisulphate (nitre cake).....ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphate powdered, U. S. P.....lb.	06 1/2 - 07	07 1/2 - 08
Sodium borate (borax).....lb.	08 1/2 - 08 1/2	09 - 09 1/2
Sodium carbonate (sal soda).....100 lb.	1.85 - 2.00	2.15 - 2.25
Sodium chlorate.....lb.	14 - 15	15 1/2 - 16 1/2
Sodium cyanide, 96-98 per cent.....lb.	26 - 27	28 - 30
Sodium fluoride.....lb.	20 - 20 1/2	21 - 22
Sodium hydroxide (caustic soda).....100 lb.	4.00 - 4.10	4.30 - 4.50
Sodium hyposulphite.....lb.		04 - 04 1/2
Sodium molybdate.....lb.	2.50 - 3.25	
Sodium nitrate.....100 lb.	3.00 - 3.25	
Sodium nitrite.....lb.	07 1/2 - 08	08 1/2 - 08 1/2
Sodium peroxide, powdered.....lb.	35 - 40	42 - 45
Sodium phosphate, dibasic.....lb.	03 1/2 - 04	04 1/2 - 05
Sodium potassium tartrate (Rochelle salts) lb.		33 - 35
Sodium prussiate, yellow.....lb.	19 - 20	20 1/2 - 21
Sodium silicate, solution (40 deg.).....lb.	01 1/2 - 01 1/2	02 - 02 1/2
Sodium silicate, solution (60 deg.).....lb.	02 1/2 - 03	03 1/2 - 04
Sodium sulphate, crystals (Glauber's salt) 100 lb.	2.15 - 2.50	2.60 - 2.75
Sodium sulphide, crystals, 60-62 percent (conc) lb.	07 - 07 1/2	07 1/2 - 08
Sodium sulphite, crystals.....lb.	04 - 04 1/2	04 1/2 - 05
Strontium nitrate, powdered.....lb.	20 - 20 1/2	21 - 22
Sulphur chloride red.....lb.	08 - 09	10 - 10 1/2
Sulphur, crude.....ton	16.00 - 20.00	
Sulphur dioxide, liquid, cylinders.....lb.	09 - 10	10 - 12
Sulphur (sublimed), flour.....100 lb.		3.70 - 4.35
Sulphur, roll (brimstone).....100 lb.		3.40 - 3.90
Tin bichloride, 50 per cent.....lb.	18 - 19	
Tin oxide.....lb.		50 - 51
Zinc carbonate, precipitate.....lb.	16 - 18	19 - 20
Zinc chloride, gran.....lb.	12 - 13	13 1/2 - 14
Zinc cyanide.....lb.	45 - 49	50 - 60
Zinc dust.....lb.	12 - 13	13 - 14
Zinc oxide, XX.....lb.	10 - 10 1/2	11 - 11 1/2
Zinc sulphate.....lb.	03 1/2 - 03 1/2	04 - 06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....lb.	1.45 - 1.50
Alpha-naphthylamine.....lb.	.44 - .46
Aniline oil, drums extra.....lb.	.26 - .27
Aniline salts.....lb.	.32 - .33
Anthracene, 80% in drums (100 lb.).....lb.	.90 - 1.00
Benzaldehyde (f.o.e.).....lb.	2.00 - 2.10
Benzidine, base.....lb.	1.15 - 1.20
Benzidine sulphate.....lb.	1.10 - 1.15
Benzoic acid, U. S. P.....lb.	.80 - .85
Benzoate of soda, U. S. P.....lb.	.80 - .90
Benzene, pure, water-white, in drums (100 gal.) gal.	.35 - .40
Benzene, 90%, in drums (100 gal.).....gal.	.33 - .38
Benzyl chloride, 95-97%, refined.....lb.	.35 - .40
Benzyl chloride, tech.....lb.	.25 - .35
Beta-naphthol benzoate (nominal).....lb.	3.50 - 4.00
Beta-naphthol, sublimed (nominal).....lb.	.75 - .80
Beta-naphthol, tech (nominal).....lb.	.40 - .45
Beta-naphthylamine, sublimed.....lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.).....lb.	.18 - .19
Ortho-cresol, in drums (100 lb.).....lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums.....gal.	1.10 - 1.15
Cresylic acid, 95-97%, dark, in drums.....gal.	1.05 - 1.10
Cresylic acid, 50%, first quality, drums.....gal.	.65 - .75
Dichlorobenzene.....lb.	.07 - .10
Diethylaniiline.....lb.	1.45 - 1.50
Dimethylaniline.....lb.	.75 - .80
Dinitrobenzene.....lb.	.30 - .37
Dinitrochlorobenzene.....lb.	.27 - .32
Dinitronaphthalene.....lb.	.42 - .45
Dinitrophenol.....lb.	.40 - .45
Dinitrotoluene.....lb.	.38 - .40
Dip oil, 25%, tar acids, car lots, in drums.....gal.	.38 - .40
Diphenylamine (nominal).....lb.	.80 - .85
H-acid (nominal).....lb.	1.65 - 1.70
Meta-phenylenediamine.....lb.	1.25 - 1.30
Monochlorobenzene.....lb.	.18 - .20
Monochloroethylaniline.....lb.	1.75 - 2.25
Naphthalene crushed, in bbls. (250 lb.).....lb.	.09 - .09 1/2
Naphthalene, flake.....lb.	.09 1/2 - .10
Naphthalene, balls.....lb.	.70 - .75
Naphthalonic acid, crude.....lb.	.12 - .15
Nitrobenzene.....lb.	.40 - .50
Nitro-naphthalene.....lb.	.18 - .20
Nitro-toluene.....lb.	3.20 - 3.75
Ortho-amidophenol.....lb.	.15 - .20
Ortho-dichlorobenzene.....lb.	.25 - .30
Ortho-nitro-phenol.....lb.	.75 - .80
Ortho-nitro-toluene.....lb.	.25 - .40
Ortho-toluidine.....lb.	.32 - .35
Para-amidophenol, base.....lb.	2.25 - 2.40
Para-amidophenol, HCl.....lb.	2.25 - 2.30
Para-dichlorobenzene.....lb.	.10 - .15
Paranitroaniline.....lb.	1.10 - 1.15

Para-nitrotoluene.....lb.	1.25 - 1.40
Para-phenylenediamine.....lb.	2.50 - 2.65
Para-toluidine.....lb.	1.85 - 2.00
Phthalic anhydride.....lb.	.60 - .70
Phenol, U. S. P., drums (dest.), (240 lb.).....lb.	.10 - .12
Pyridine.....gal	2.00 - 3.50
Resorcinol, technical.....lb.	2.90 - 3.00
Resorcinol, pure.....lb.	3.75 - 4.15
Salicylic acid, tech., in bbls. (110 lb.).....lb.	.35 - .38
Salicylic acid, U. S. P.....lb.	.40 - .45
Salol.....lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal. gal.	.30 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.19 - .22
Sulphanilic acid, crude.....lb.	.32 - .35
Tolidine.....lb.	1.75 - 1.80
Toluidine, mixed.....lb.	.45 - .55
Toluene, in tank cars.....gal.	.35 - .40
Toluene, in drums.....gal.	.41 - .42
Xylidines, drums, 100 gal.....lb.	.50 - .65
Xylene, pure, in drums.....gal.	.45 - .47
Xylene, pure, in tank cars.....gal.	.45 - .47
Xylene, commercial, in drums, 100 gal. gal.	.37 - .38
Xylene, commercial, in tank cars.....gal.	.30 - .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....lb.	\$0.31 - \$0.33
Beeswax, refined, light.....lb.	.34 - .37
Beeswax, white pure.....lb.	.55 - .60
Carnauba, No. 1 (nominal).....lb.	.80 - .90
Carnauba, No. 2, regular (nominal).....lb.	.70 - .80
Carnauba, No. 3, North Country.....lb.	.25 - .26
Japan.....lb.	.19 - .20
Montan, crude.....lb.	.12 - .14
Paraffine waxes, crude match wax (white) 105-110 m.p.....lb.	.08 - .08 1/2
Paraffine waxes, crude, scale 124-126 m.p.....lb.	.08 - .08 1/2
Paraffine waxes, refined, 118-120 m.p.....lb.	.09 - .09 1/2
Paraffine waxes, refined, 125 m.p.....lb.	.09 1/2 - .09 1/2
Paraffine waxes, refined, 128-130 m.p.....lb.	.10 - .11
Paraffine waxes, refined, 133-135 m.p.....lb.	.13 - .14
Paraffine waxes, refined, 135-137 m.p.....lb.	.14 - .15
Stearic acid, single pressed.....lb.	.17 - .17 1/2
Stearic acid, double pressed.....lb.	.18 - .19
Stearic acid, triple pressed.....lb.	.22 - .23

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr. 0.930-0.940.....gal.	\$1.90
Pine oil, pure, dest. dist.....gal.	1.50
Pine tar oil, ref., sp. gr. 1.025-1.035.....gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990.....gal.	.75
Pine tar, ref., thin, sp. gr. 1.080-1.060.....gal.	.36
Turpentine, crude, sp. gr. 0.900-0.970.....gal.	1.25
Hardwood oil, f.o.b. Mich., sp. gr. 0.960-0.990.....gal.	.35
Pinewood creosote, ref.....gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.....280 lb.	\$11.75 -
Rosin E-L.....280 lb.	11.75 -
Rosin K-N.....280 lb.	11.75 -
Rosin W. G.-W. W.....280 lb.	12.00 - 12.25
Wood rosin, bbl.....280 lb.	11.00 -
Spirits of turpentine.....gal.	1.10 -
Wood turpentine, steam dist.....gal.	1.08 -
Wood turpentine, dest. dist.....gal.	1.02 -
Pine tar pitch, bbl.....200 lb.	8.50 -
Tar, kiln burned, bbl. (500 lb.).....bbl.	15.00 -
Retort tar, bbl.....500 lb.	15.00 -
Rosin oil, first run.....gal.	.70 -
Rosin oil, second run.....gal.	.73 -
Rosin oil, third run.....gal.	.90 -

Solvents

73-76 deg., steel bbls. (85 lb.).....gal.	\$0.41
70-72 deg., steel bbls. (85 lb.).....gal.	.39
68-70 deg., steel bbls. (85 lb.).....gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.).....gal.	.30

Crude Rubber

Para-Upriver fine (nominal).....lb.	\$0.22 - \$0.23
Upriver coarse (nominal).....lb.	.15 - .16
Upriver cauchoo ball (nominal).....lb.	.16 1/2 - .17 1/2
Plantation—First latex crepe.....lb.	.19 -
Ribbed smoked sheets.....lb.	.18 -
Brown crepe, thin, clean.....lb.	.16 -
Amber crepe No. 1.....lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.....lb.	\$0.14 - \$0.15
Castor oil, AA, in bbls.....lb.	.15 - .16 1/2
China wood oil, in bbls. (f.o.b. Pac. coast).....lb.	.13 - .14
Cocanut oil, Ceylon grade, in bbls.....lb.	.14 - .14 1/2
Cocanut oil, Cochon grade, in bbls (nominal).....lb.	.15 - .16
Corn oil, crude, in bbls.....lb.	.11 - .11 1/2
Cottonseed oil, crude (f.o.b. mill).....lb.	.08 - .08 1/2
Cottonseed oil, summer yellow.....lb.	.10 - .11
Cottonseed oil, winter yellow.....lb.	.13 - .14
Linseed oil, raw, car lots (domestic).....gal.	.85 -
Linseed oil, raw, tank cars (domestic).....gal.	.80 -
Linseed oil, boiled, car lots (domestic).....gal.	.87 -

Olive oil, commercial.....	gal.	2.75	—	3.00
Palm, Lagos.....	lb.	.09	—	.09
Palm, Niger.....	lb.	.09	—	.09
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.09
Peanut oil, refined, in bbls.....	lb.	.15	—	.15
Rapeseed oil, refined in bbls.....	gal.	1.15	—	1.20
Rapeseed oil, blown, in bbls.....	gal.	1.25	—	1.35
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.11	—	.11
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.08	—	.08

FISH

Light pressed Menhaden.....	gal.	\$0.65	—	\$0.70
Yellow bleached Menhaden.....	gal.	.67	—	.70
White bleached Menhaden.....	gal.	.72	—	.75
Blown Menhaden.....	gal.	1.05	—	1.10

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	10.00
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Casein.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia.....	net ton	9.00	—	12.00
China clay (Kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York.....	net ton	—	—	18.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	—
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	—	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	—
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) flat to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1 1/2 in. f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.00	—	1.05
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Sodium Chloride.....	long ton	—	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh.....	1,000	—	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	55-60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	—	45-50
Magnesite brick, 9-in. straight.....	net ton	110	—
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—
Magnesite brick, soaps and splits.....	net ton	134	—
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	—	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	—	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	—	55-60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.18	—	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	170.00	—	175.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	165.00	—	170.00
Spiegeleisen, 18-22% Mn.....	gross ton	75.80	—	80.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	60.00	—	65.00
Ferro-silicon, 50%.....	gross ton	80.00	—	85.00
Ferro-silicon, 75%.....	gross ton	—	—	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	.75	—	.90
Ferro-uranium, 35-50% of U, per lb. of U content lb.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	6.50	—	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H ₂ O moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min.....	unit	.70	—	.75
Cr ₂ O ₃	unit	.65	—	.75
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.65	—	.75
Coke, foundry, f.o.b. ovens.....	net ton	10.00	—	12.00
Coke, furnace, f.o.b. ovens.....	net ton	8.00	—	10.00
Coke, petroleum, refinery, Atlantic Seaboard.....	net ton	24.00	—	26.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	—	—
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	25.00	—	27.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.014	—	.014
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	—	—	.50
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	70.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.65	—	.70
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	35.00	—	—
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	—
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.17	—	—
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	6.00	—	—
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.50	—	5.00
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	2.00	—	—
Zircon, washed, iron free.....	lb.	.05	—	—

Non-Ferrous Metals

New York Markets

	Cents per lb.
Copper, electrolytic.....	15.75
Aluminum, 98 to 99 per cent.....	38.75
Antimony, wholesale lots, Chinese and Japanese.....	6.12 @ 6.25
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Tin, 5-ton lots.....	39.00
Lead, New York, spot.....	7.25
Lead, E. St. Louis, spot.....	7.05
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.60

OTHER METALS

Silver (commercial).....	oz.	\$0.91 1/2
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.55
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Niagara Falls).....	lb.	1.75
Platinum.....	oz.	85.00 @ 90.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	85.00
Mercury.....	75 lb.	58.00 @ 60.50

FINISHED METAL PRODUCTS

Warehouse Price
Cents per lb.

Copper sheets, hot rolled.....	23.50
Copper bottoms.....	34.00
Copper rods.....	29.00
High brass wire and sheets.....	27.50
High brass rods.....	19.00
Low brass wire and sheets.....	30.50
Low brass rods.....	24.00
Brazed brass tubing.....	36.25
Brazed bronze tubing.....	41.50
Seamless copper tubing.....	28.00
Seamless high brass tubing.....	27.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland				Chicago			
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Copper, heavy and crucible.....	12.50	17.00	12.00	13.50	12.00	16.00	11.75	12.50	12.00	16.00	11.75	12.50
Copper, heavy and wire.....	12.00	16.00	11.75	12.50	12.00	16.00	11.75	12.50	12.00	16.00	11.75	12.50
Copper, light and bottoms.....	10.00	14.00	10.00	11.00	10.00	14.00	10.00	11.00	10.00	14.00	10.00	11.00
Lead, heavy.....	5.50	4.75	5.50	6.00	5.50	4.75	5.50	6.00	5.50	4.75	5.50	6.00
Lead, tea.....	4.50	3.75	4.50	5.00	4.50	3.75	4.50	5.00	4.50	3.75	4.50	5.00
Brass, heavy.....	7.00	10.50	8.00	12.50	7.00	10.50	8.00	12.50	7.00	10.50	8.00	12.50
Brass, light.....	5.50	7.50	5.00	6.50	5.50	7.50	5.00	6.50	5.50	7.50	5.00	6.50
No. 1 yellow brass turnings.....	7.00	10.00	6.00	6.75	7.00	10.00	6.00	6.75	7.00	10.00	6.00	6.75
Zinc.....	4.50	5.00	3.75	5.00	4.50	5.00	3.75	5.00	4.50	5.00	3.75	5.00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland			Chicago		
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago	Current
Structural shapes.....	\$4.15	\$4.47	\$3.47	\$3.44	\$3.37	\$4.08	\$3.47		
Soft steel bars.....	4.15	4.62	3.37	3.84	3.27	3.98	3.37		
Soft steel bar shapes.....	4.15	4.62	3.37	3.84	3.27	3.98	3.37		
Soft steel bands.....	5.50	6.32	4.07	6.25					
Plates, 1/2 to 1 in. thick.....	4.15	4.67	3.67	3.64	3.57	4.28	3.67		

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

PASADENA—Throop College of Technology, East California St., has awarded the contract for the construction of a 1-story laboratory to W. C. Crowell, Chamber of Commerce. Estimated cost, \$150,000.

WATTS—The city plans to construct a sewage disposal plant. Koebig & Koebig, 341 Fire Insurance Bldg., Los Angeles, consult. engrs.

Colorado

DENVER—The State Bd. of Regents plans to build a hospital and laboratory for the curable insane. Bonds were authorized last election Nov. 2 for the construction.

WELLINGTON—The Du Pont Sugar Co., 627 19th St., Denver, will soon award the contract for the construction of a sugar factory. Estimated cost, \$1,000,000. Schwartz Eng. Co., 310 Mack Bldg., Denver, engr.

Illinois

CHICAGO—The Union Stock Yards Casting Co., 834 West 49th Pl., is having plans prepared for the construction of a 1- and 2-story, 60x125-ft. foundry at 4843 South Morgan St. Estimated cost, \$28,000. O. Ritter, 140 South Dearborn St., archt.

WAUKEGAN—The city plans to construct a filtration plant, pumping station and intake. Estimated cost, \$600,000. Hood & Decker, engrs.

Iowa

AMES—The city will receive bids in February for the construction of a sewage disposal plant, etc. Estimated cost, \$125,000. P. F. Hophens, engr.

Kansas

TOPEKA—The city is having plans prepared for the construction of a filtration and softening plant using the Kansas River water. Estimated cost, \$535,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., engrs. Noted Oct. 6.

Maryland

BALTIMORE—The Baltimore Mfg. Co., manufacturer of chemicals, vinegar, yeast, etc., controlled by the Fleischmann Co., Perry and Plum Sts., Cincinnati, O., plans to construct additions to its 2 plants on Buren and Monument Sts. and Central Ave. and Bank St. Estimated cost, \$1,000,000.

Minnesota

ST. PAUL—The city voted \$3,000,000 bonds to enlarge water plant, including filter plant, etc. Oscar Claussen, City Hall, engr.

Missouri

ST. LOUIS—The Perfection Mfg. Co., Montgomery and Leffingwell Sts., will build a 1-story, 60x60-ft. enameling plant at 2701 Leffingwell St. Estimated cost, \$7,000. Work will be done by day labor.

New York

HADLEY—The No Era Paper Co. has awarded the contract for the construction of an addition and alterations to the machine shop to the H. P. Cummings Constr. Co., 14 Prospect St., Ware, Mass. Estimated cost, \$100,000.

LONG ISLAND CITY—James H. Rhodes & Co., 115 Fulton St., New York City, has awarded the contract for the construction of a factory for the manufacture of abrasives and polishing materials to the Guarantee Constr. Co., 140 Cedar St., New York City. Estimated cost, \$200,000.

ROCHESTER—The Bartholmay Brewing Co., 555 St. Paul St., is in the market for \$100,000 worth of machinery for crude oil refining.

Ohio

ELYRIA—The Lakeshore Rubber Co., 734 Natl. City Bldg., Cleveland, has awarded the contract for the construction of a 2-story factory, to the Donnelly Constr. Co., Lorain. Estimated cost, \$150,000.

WARREN—Brier Hill Steel Co., Youngstown, has taken an option on a 480-acre site for the purpose of constructing a steel mill. Estimated cost, \$1,500,000. E. L. Ford, chn. of the Advisory Com.

Oklahoma

VINITA—The city voted \$460,000 bonds to construct 2 dams, purification plant, etc. H. G. Olmsted, 417 Oil Exch., Oklahoma City, engr.

Pennsylvania

PHILADELPHIA—The L. Martin Co., Milnor St. south of Bleigh St., will build a 1-story, 27x47x55-ft. addition to its lamp-black factory. Estimated cost, \$25,000. Work will be done by day labor.

PHILADELPHIA—The Westmoreland Color & Chemical Co., 22d and Allegheny Sts., has awarded the contract for the altering its present factory, to McNeil Valentine, 841 North Broad St. Estimated cost, \$10,000.

Texas

CORPUS CHRISTI—W. A. Chambers will build an oil refinery to have a daily capacity of 1,500 bbl. of refined oil and gasoline. Estimated cost, \$100,000. Work will be done by day labor.

Wisconsin

AMHERST—The Bd. Educ. is having preliminary plans prepared for the construction of a 3- or 4-story, 60x150-ft. high school on North Main St. A chemical and physical laboratory will be installed in same. Estimated cost, \$200,000. W. C. Alban, Endicott Bldg., St. Paul, Minn., archt.

APPLETON—The Fox River Paper Co. has awarded the contract for the construction of a 2-story, 26x165-ft. paper mill to the Appleton Constr. Co.

FOND DU LAC—The Fond du Lac Paper Co., 298 Forest Ave., is having plans prepared for the construction of a 1- and 2-story, 100x300-ft. paper board factory. F. Stepnoski, 144 Marquette St., archt. Noted Nov. 3.

FREDERICK—The Bd. Educ., Lynn Bldg., is having plans prepared for the construction of a 2-story, 100x175-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$140,000. E. J. Hancock, Eau Claire, archt. and engr.

GRANVILLE—The T. J. Moss Tie Co., Security Bldg., St. Louis, Mo., plans to construct a tie treating plant, including 3 steel buildings. Estimated cost, \$100,000. J. S. Penney, engr.

JEFFERSON—The Jefferson Rubber Co. is building a 1-story, 80x320-ft. tire factory on Main St. Estimated cost, \$100,000.

WEBSTER—The Bd. Educ. is having plans prepared for the construction of a 2-story, 160x175-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$175,000. E. J. Hancock, Eau Claire, archt. and engr.

New Brunswick

BEAR RIVER—The Clarke Bros., Ltd., will receive bids until Jan. 15 for the construction of a paper mill. Estimated cost, \$100,000.

New Foundland

BONNE BAY—The St. Lawrence Timber Pulp & Steamship Co., Ltd., plans to build a plant including a sulphite mill.

Ontario

LONDON—E. T. Jenkins, Y. M. C. A., 429 Wellington St., plans to build a Y. M. C. A. building. A chemical purification system for a swimming pool will be installed in same. Estimated cost, \$300,000.

Quebec

MONTREAL—The Royal Duke Refining Co., 157 St. James St., plans to build a plant in East Montreal. Plans include equipment. Estimated cost, \$250,000.

New Publications

THE CASTOR-OIL INDUSTRY, by J. H. Shrader. Bull. 867 issued by the U. S. Department of Agriculture.

ARTHUR D. LITTLE, INC., chemist and engineer, 30 Charles River Road, Cambridge, Mass., announces that a limited number of copies of its monograph on "The Petroleum Outlook" are now available for distribution to bankers, brokers, manufacturers and investors free of charge on application. This work comprises an economic study of "The Petroleum Outlook," with especial reference to American fields, a large map and several charts, arranged for comparative reference, with an illuminating discussion of the status of the numerous oil fields. The text, written in popular style, deals with the geology, production history and apparent state of exhaustion of our petroleum resources and may readily be understood by any intelligent layman. It is an impartial, forceful presentation of the petroleum problem without reference to the companies or interests that own or operate in the respective sections. This is one of the most complete and interesting publications for the lay reader that has been issued upon this subject.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS 1920 annual meeting will be held in the Engineering Societies Building from Dec. 7 to 10 inclusive.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at the Statler Restaurant, Newark, N. J., the second Monday of every month.

TAYLOR SOCIETY will hold its annual meeting Dec. 2, 3 and 4 in the Engineering Societies Bldg., New York City. The meeting of Dec. 3 at 8 p.m. will be of special interest to metallurgists. The subject will be "The Long Day in the Steel Industry."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Dec. 10, American Chemical Society, joint meeting with Society of Chemical Industry, American Electrochemical Society and Société de Chimie Industrielle; Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.